WR 07

velopment
ooperation
Ireland
DEPARTMENT OF FOREIGN AFFAIRS

WWF

Belgian
Development Cooperation
.be

Mangroves of Western and Central Africa

Report written and compiled by:

Emily Corcoran, Corinna Ravilious, Mike Skuja

Report produced for UNEP-DEPI under the UNEP Biodiversity Related Projects in Africa

UNEP WCMC

Regional Seas

Digitized by the Internet Archive
in 2010 with funding from
UNEP-WCMC, Cambridge

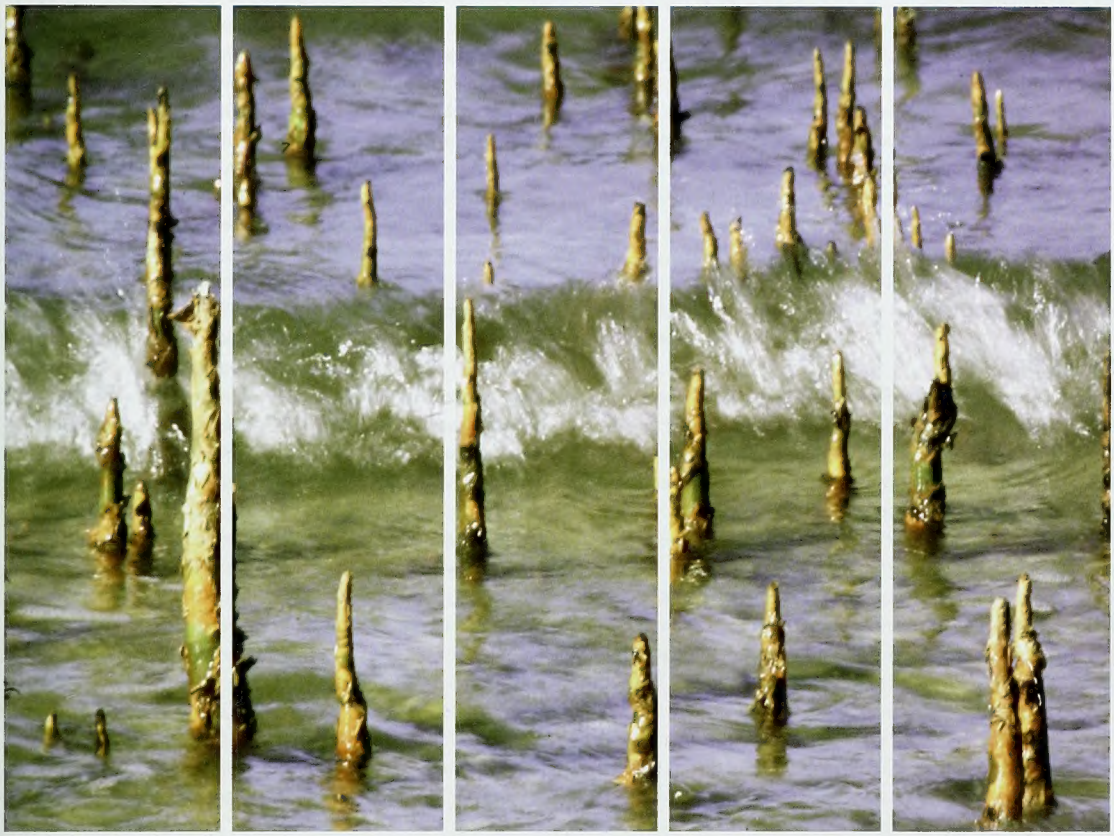
http://www.archive.org/details/mangrovesofweste07corc

Development Cooperation Ireland
DEPARTMENT OF FOREIGN AFFAIRS

WWF

Belgian Development Cooperation .be

Mangroves of Western and Central Africa



Report written and compiled by:

Emily Corcoran, Corinna Ravilious, Mike Skuja

Report produced for UNEP-DEPI under the UNEP Biodiversity Related Projects in Africa

UNEP WCMC

Regional Seas

UNEP World Conservation Monitoring Centre
219 Huntingdon Road,
Cambridge CB3 0DL,
United Kingdom
Tel: +44 (0) 1223 277314
Fax: +44 (0) 1223 277136
Email: info@unep-wcmc.org
Website: www.unep-wcmc.org

©UNEP-WCMC/UNEP June 2007

ISBN: 978-92-807-2792-0

COMPILATION TEAM

Emily Corcoran, Corinna Ravilious, Mike Skuja

CITATION

UNEP (2007)*Mangroves of Western and Central Africa.* UNEP-Regional Seas Programme/UNEP-WCMC.

This publication is available online at
http://www.unep-wcmc.org/resources/publications/UNEP_WCMC_bio_series/26.htm

ACKNOWLEDGEMENTS

UNEP-WCMC gratefully acknowledges the financial contribution of the Government of Ireland, the Government of Belgium and WWF, the global conservation organization, for the production of this report and the assistance of the UNEP Regional Seas Programme and UNEP DEWA for its publication. The assistance of the Secretariat of the Abidjan Convention is recognized for facilitating the review of the draft report. UNEP-WCMC would also like to thank all of those that responded to our requests for review and additional information based in the countries covered by this report, their contributions, their help, papers, data and communications have been essential to the accuracy and saliency of this report including: Ebeh Adayade Kodjo, Elijah Ohimain, Lee White, Ayobami T. Salami, Gordon Ajonina, Ndongo Din, Jean Nke, Abou Bamba, A.K. Armah, Chris Gordon, Gail W. Hearn, Jean Pierre Vande weghe, Salif Diop, Mamadou Sow, and Abilio R. Said. A list of the names and affiliations of those who have contributed is presented as Annex 3. Thanks are also due to FAO for their continued collaboration and supply of the Landsat images used to derive the maps included in this report, and to colleagues within UNEP-WCMC who have assisted in this project, in particular Edmund McManus, Michelle Taylor, Simon Blyth, and Claire Brown.

A Banson production
Design and layout J-P Shirreffs
Printed in the UK by The Lavenham Press

DISCLAIMER

The contents of this report do not necessarily reflect the views or policies of UNEP or contributory organizations. The designations employed and the presentations do not imply the expressions of any opinion whatsoever on the part of UNEP or contributory organizations concerning the legal status of any country, territory, city or area and its authority, or concerning the delimitation of its frontiers or boundaries.

For all correspondence relating to this report please contact:
info@unep-wcmc.org

UNEP promotes environmentally sound practices, globally and in its own activities. This report is printed on 100% recycled paper, using vegetable-based inks and other eco-friendly practices. Our distribution policy aims to reduce UNEP's carbon footprint.

Foreword

There is an international consensus, expressed in the Convention on Biological Diversity, World Summit on Sustainable Development, and Millennium Ecosystem Assessment, that biodiversity at all levels – genetic, species and ecosystem – have a critical role in sustaining livelihoods and human development. They underpin and make possible all forms of economic activity. Damage to components of biodiversity have economic consequences, the impacts of which fall most heavily on the poor. In few contexts is this as clear as in the case of mangrove ecosystems and their dependent human populations.

Mangroves support livelihoods in providing habitat for food species, timber for dwellings, cooking and heat, and many other subsistence and commercial activities. Mangroves also provide protection of the coastline from erosion and storm surges. The roles of mangroves are now being realised, but only as the general trend for this valuable habitat is decline.

The first global attempt to document the status of the mangrove resource, the World Mangrove Atlas, was published in 1997 by the International Society for Mangrove Ecosystems (ISME), financed by ITTO and in partnership with UNEP-WCMC. The information for Africa was updated by UNEP-WCMC in the publication Mangroves of East Africa (2003). This report provides a profile for the 19 countries of the region from Mauritania south to Angola. It presents new information on the distribution of these habitats and highlights the importance of mangroves of west and central Africa in the regional and global context. It serves to illustrate the benefits human communities derive from the wide range of goods and services provided by mangroves, which are valued at up to US$ 900 000 per year. The region is in a time of rapid change, with many challenges and opportunities, some of the highest levels of poverty in the world, a population aspiring for change, and strong interest from extractive industries in the region. Policy-makers have some difficult choices ahead as to how to manage their natural resources. It is vital that they can be provided with the most up-to-date information available. It is hoped that this publication can contribute to fulfilling their information needs for considering the future management of mangrove ecosystems in the region.

Although there is considerable work being undertaken to research this habitat at the national, regional and global levels, there are still significant gaps in information, and a need for continued efforts to improve assessment of West and Central African mangrove habitats. The data produced and presented here represents the best data available today. For this reason, it is critical that it is accessible by stakeholders in the region, and can contribute to informing decisions regarding the use of mangrove ecosystems. The report will be made available as a printed report, online as a pdf and will also be made available as a contribution to the revised *World Atlas of Mangroves*, being undertaken by a partnership between ISME, ITTO, FAO, UNEP-WCMC, UNU-INWEH and UNESCO-MAB. UNEP-WCMC spatial data can be viewed at http://www.unep-wcmc.org.

H.E. Ahizi Aka Daniel,
Minister of Environment, Waters and Forests
The Republic of Côte d'Ivoire

Avant-propos

La biodiversité joue un rôle critique dans la préservation et le maintien des moyens de subsistance et dans le développement humain à tous les niveaux : de la génétique en passant par les espèces jusqu'aux écosystèmes. Elle est à la base de toutes les formes d'activités économiques. La dégradation des éléments constitutifs de la diversité biologique comporte un certain nombre de conséquences économiques dont les impacts se répercutent grandement sur la frange des populations les plus pauvres. Ceci est d'autant plus évident dans le cas des écosystèmes de mangroves et des populations qui en dépendent.

Les mangroves constituent une importante source de revenues et de moyens de subsistance parmi lesquels : l'habitat pour certaines espèces, le bois de construction et le bois de chauffe ainsi que plusieurs autres activités de subsistance et commerciales. Les mangroves contribuent aussi à la protection des côtes contre l'érosion et les tempêtes de mer. Le rôle de la mangrove est en train d'être connu au moment où la tendance générale pour cet important habitat est en déclin.

La première tentative pour donner des détails sur l'état des ressources de la mangrove, « Atlas Mondial des Mangroves », a été publiée en 1997 par l'ISME (Société Internationale des Ecosystèmes de Mangroves, en français) financée par l'ITTO (Organisation Internationale des Bois Tropicaux, en français) et en partenariat avec le PNUE-WCMC. Les informations sur les mangroves d'Afrique ont été mises à jour par le PNUE-WCMC dans le cadre de la publication sur « Les Mangroves d'Afrique de l'Est (2003)». Le présent rapport donne une description de l'état actuel des mangroves dans 19 pays de la sous-région; de la Mauritanie au sud de l'Angola. Le rapport indique les avantages économiques que les communautés humaines tirent du large éventail des biens et services que procurent les mangroves, bénéfices évalués à quelques 900.000 dollars US par an. La sous-région ouest africaine connaît de nos jours des changements rapides avec des opportunités mais aussi de nombreux défis au nombre desquels, un degré de pauvreté parmi les plus élevés au monde, des populations qui aspirent au changement, et un grand intérêt pour les industries d'extraction. Les décideurs politiques sont confrontés à un certain nombre de choix difficiles, parmi lesquels la gestion durable de leurs ressources naturelles. Il est donc vital de mettre à la disposition des décideurs les informations les plus récentes et mises à jour. Nous espérons que cette publication pourra combler ce besoin et aider les décideurs à mieux gérer les écosystèmes de mangroves de la région.

En dépit d'un travail considérable de recherche en cours au niveau de cet écosystème et à différentes échelles tant nationale, régionale que globale, il semble y avoir une insuffisance d'informations, et par conséquent un besoin accru pour mieux évaluer les écosystèmes de mangroves de l'Afrique de l'Ouest et du Centre. Les données présentées dans ce rapport sont les meilleures à ce jour que l'on ait pu obtenir. Pour cette raison, il importe que le présent rapport puisse être mis à la disposition de l'ensemble des parties prenantes dans la sous-région ; et ceci afin de permettre aux décideurs de pouvoir disposer des meilleures informations possibles pour une gestion durable des écosystèmes de mangroves. Le présent rapport sera publié en plusieurs versions : une version imprimée, une version électronique en format PDF. Ce rapport constitue une contribution à « l'Atlas Mondial des Mangroves » révisé, qui est en cours de réalisation en partenariat avec ISME, ITTO, FAO, PNUE-WCMC, UNU-INWEH et UNESCO-MAB. Les données spatiales du PNUE-WCMC sont disponibles et peuvent être visualisées par cartographie interactive à l'adresse suivante: http://www. unep-wcmc.org.

S.E. Ahizi Aka Daniel,
Ministre de l'Environnement,
des Eaux et Forêts de Côte d'Ivoire

Key Messages

1. Almost one fifth of the world's mangroves are found in Sub-Saharan Africa, and 70 per cent of these are found in 19 countries of West Africa.

2. West African mangroves are in moderate decline, with average estimates reducing by a quarter between 1980 and 2006. The Atlantic coast of Africa has some of the highest population densities on the continent and the majority of industry of West Africa is located in the coastal zone. This combined with rapid growth, high poverty, low development indices, poor governance in rural regions and open access of coastal resources suggest urgent and coordinated action is needed to halt this current trend.

3. Fourteen per cent of identified mangrove areas in West Africa fall within nationally and internationally designated protected areas; however, there are strong concerns about the management coordination and effectiveness of these protected areas, predominantly due to financial and administrative constraints of the region.

4. Four key drivers have been identified as the principal factors influencing mangrove change in West Africa:
   Population growth
   Economic and political trends
   Climate change
   Changes in upstream habitat

5. Governance and sustainable management of mangrove areas in the region is likely to be complex with strong competition between economic activities taking place. High numbers of people are dependent on the mangroves for subsistence and small-scale commercial activities, which rely on the long-term functioning of the ecosystem, unlike activities that generate higher revenues over the shorter term with high risk to environmental integrity. There is some concern that the long-term values of intact and functioning mangrove ecosystems are not being recognized in the coordination and application of current policy strategies and decisions, where short-term gain resulting in loss of the ecosystem is being pursued at the expense of long-term sustainability.

6. Where analyses to demonstrate the values of the wide range of goods and services provided by mangrove habitats have been undertaken, they have proven to be a valuable tool in assisting decision-makers. One estimate of the economic value of one square kilometre of mangrove ranges between US$ 200 000 and US$ 900 000 per year.

7. Currently only two countries in West Africa refer to mangroves in their national Poverty Reduction Strategy Papers (PRSPs). There is precedence to include mangrove habitat within Poverty Reduction Strategy Papers, where there is evidence that the goods and services provided by the habitat are important to sustaining livelihood strategies and food security.

8. The sustainable management of mangrove ecosystems throughout the West African region will be an essential contribution to the proposed new target for the Millennium Development Goals to "Reduce biodiversity loss, achieving a significant reduction in the rate of loss by 2010"[1].

[1] The biodiversity target is one of four new targets to be included within the MDGs, as proposed by the UN Secretary-General in his report to the 61st General Assembly, September 2006 (see A/61/1 at **www.un.org/ga/61/documentation/list.shtml).**

Contents

FOREWORD 3
AVANT-PROPOS 4

KEY MESSAGES 5

READER'S GUIDE AND TECHNICAL NOTES 7
KEY TO THE MAPS 10

A CONTINENTAL OVERVIEW 11
- What are mangroves? 11
- Status and distribution 11
- Why are mangroves important to human well-being in Africa? 11
- Associated biodiversity 13
- Threats and drivers of change 13

REGIONAL OVERVIEW 16
- Status 16
- Biodiversity 16
- Main uses of mangroves and associated economic activity 17
- Threates and drivers of change 18

NATIONAL PROFILES
- Mauritania 25
- Senegal 27
- Gambia 31
- Guinea Bissau 35
- The Republic of Guinea 37
- Sierra Leone 41
- Liberia 43
- Côte d'Ivoire 47
- Ghana 49
- Togo 53
- Benin 57
- Nigeria 59
- Cameroon 63
- Equatorial Guinea 67
- São Tomé and Príncipe 69
- Gabon 71
- Congo 75
- Democratic Republic of the Congo 77
- Angola 81

ANNEX 1: GENERAL REFERENCES 82
ANNEX 2: MANGROVE SPECIES OF WEST AFRICA 87
ANNEX 3: CONTRIBUTING MANGROVE EXPERTS 87
ANNEX 4: AN ECONOMIC TOOLBOX FOR PLACING VALUE ON MANGROVE PRODUCTS AND SERVICES 87

Reader's Guide and Technical Notes

These notes are intended to provide the reader with background information on the source data to better understand the information presented and its limitations.

This report is supported by an interactive online map (Mangrove Review IMAPS), which is available for the user to browse and comment on at:

http://bure.unep-wcmc.org/imaps/marine/mangroves/viewer.htm

The reader is encouraged to visit the IMAPS and provide feedback on the spatial data.

Please note that The "Convention on Wetlands of International Importance especially as Waterfowl Habitat" is referred to throughout this report as the "Ramsar Convention". Sites designated under this convention are referred to as "Ramsar Sites".

SOURCES OF STATISTICAL INFORMATION

The report uses a range of statistics in the summary tables for the overviews and country profiles. The tables below provide source information.

Land Area (km^2)	FAOSTAT 2003
Coastline (km^2)	Earthtrends, 2001 [Source: Coastal length data are based on the World Vector Shoreline, United States Defense Mapping Agency, 1989. Figures were calculated by L. Pruett and J. Cimino, unpublished data, Global Maritime Boundaries Database (GMBD), Veridian – MRJ Technology Solutions, (Fairfax, Virginia, January, 2000)]
Population (2004)	Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat
Population density (per km^2)	Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat
Annual population growth rate (%) 2005–2010	Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat
Number of mangrove species in country	FAO, in press
Current mangrove area	UNEP-WCMC, 2006
% of African mangrove cover	UNEP-WCMC, 2006
Estimated change in area 1980–2006	Derived from estimated area data
Area of designated national and international protected areas containing mangroves	World Database of Protected Areas, UNEP-WCMC, 2006

SOURCES OF ESTIMATED MANGROVE COVER DATA

The mangrove area estimates are derived from a variety of sources, as follows:

1980	Estimates derived from regression analysis, FAO, in press
1990	Estimates derived from regression analysis, FAO, in press
1997	Spalding *et al.*, 1997
2000	FAO of the UN, Global Forest Resources Assessment, 2000
2005	FAO of the UN, Global Forest Resources Assessment, 2005
2006	UNEP-WCMC

CATEGORIZATION OF ESTIMATES OF MANGROVE COVER CHANGE:

Estimated area data for mangroves over the years has, as is discussed below, been derived from a number of sources, using a number of methods. It is not therefore impossible to provide accurate figures for estimated change in mangrove area cover. Instead, four categories are defined as follows:

Increase	An increase in mangrove area
No change	Change based on estimates is 5%
Slight decline	Change based on estimates is 5%–20%
Moderate decline	Change based on estimates is 21%–50%
Severe decline	Change based on estimates is 50%

TECHNICAL NOTES

The UNEP-WCMC 2006 mangrove data for West Africa represent mangrove coverage for circa 2000. Data have been compiled through processing of Landsat TM 5 and Landsat 7 ETM+ images dating predominately from 1999–2001. The images were prepared to match each other as closely as possible spatially, spectrally and radiometrically. Corrections were applied to remove atmospheric effects from the imagery to create a reflectance image. The objective was to retrieve the surface reflectance (that characterizes the surface properties) from remotely sensed imagery. Atmospheric correction is shown to significantly improve the accuracy of image classification and has been applied consistently to each image. The technique used was based on the COST method (an image-based correction procedure by Chavez, 1996).

To improve the accuracy of distinguishing mangroves from other categories, the images were cropped to remove those areas beyond which mangroves are known not to occur. Areas of interest (AOIs) were created manually. The clarity of the mangroves varied between images, so whilst creating the AOIs, it was important to include all areas with potential mangroves. The images were subset to include only the AOIs in bands 5, 4, 3 as this was deemed the best combination for detecting mangrove.

An unsupervised classification was applied to identify the mangrove areas (i.e. there was no user input or field data used in category determination). The unsupervised classification was run to produce a preliminary 20-class classification. Subsequently, visual comparison between the raw satellite image and the preliminary classification was necessary as well as looking at the mean spectral signatures of the different classes (Figure 1). The UNEP-WCMC global mangrove layer from Spalding *et al.* (1997) was also used as a visual aid for selection. An initial 20 classes was chosen to ensure that the mangrove areas were distinguished from other vegetation types. Due to the small areas covered by mangroves, other land-cover classes would otherwise be more prominent and the mangrove selection becomes less defined. On the 543-band images, the mangroves appear very dark green.

Results from unsupervised classification can be quite varied and there may be some confusion between classes. One class, for example, may clearly be mangrove but also

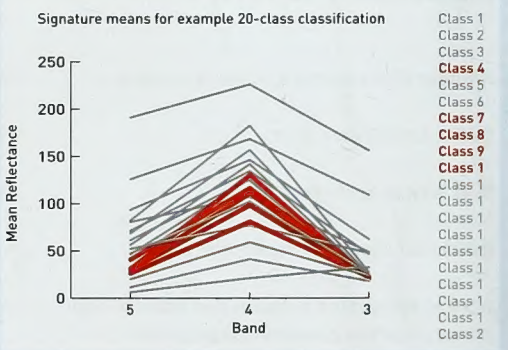


Figure 1: Graph to show an example of spectral means of a classified 20-class Landsat image. The spectral signatures in red represent mangrove. In the 543 band image, the signature for mangroves is shown by the following combination of spectral ranges for bands 5, 4 and 3. The spectral ranges for band 5 must fall between 25 and 45, for band 4 between 80 and 130 and for band 3 between 20 and 30.

Figure 2: Example map to show improvements in mapped mangrove data from UNEP-WCMC global mangrove layer from Spalding *et al.* (1997) to UNEP-WCMC global mangrove layer 2006.

contain pixels from areas that are clearly not mangrove. In these cases, further contextual editing of the classified 20-class image was required to eliminate these pixels. This was a manual process. It was important at this stage to also look at adjacent images to ensure consistency and help deal with problem areas. The mangrove classes were finally filtered out to create the mangrove data layer.

Direct comparison to identify change in extent between this 2006 update and the data produced for the UNEP-WCMC global mangrove layer from Spalding *et al.* (1997) is not possible due to significant differences in data collection methodologies and scale of data (see Figure 2).

LIMITATIONS

Some contextual editing has been carried out to eliminate potential problems with the data. However, no formal procedure was run to detect clouds. Those images that had high levels of cloud may need to be revised to ensure that a) clouds and cloud shadows have not been interpreted as mangrove, b) those areas that were affected by cloud have been adequately filled in from other sources.

Area estimates based on this 2006 analysis have identified some anomalies. As always, statistics should be treated with caution. An apparent gain or loss in mangrove area compared to other estimates may not reflect the actual situation on the ground. This analysis has been undertaken using 30-metre resolution imagery, which is far more detailed than imagery in previous analyses. Figure 2 illustrates how a simple difference in resolution can significantly alter area figures. Likewise, a small misclassification of the imagery will affect the area figures. The transition from coarser-resolution information from paper maps to the use of high-resolution satellite data is a significant change in data resolution. Future analysis based on similar resolution imagery will allow a much more accurate picture of change in extent of mangroves to be identified.

REQUEST FOR FEEDBACK

We greatly value any feedback which enables us to validate our interpretation of the location of mangrove areas. We have already received feedback from Mauritania, Nigeria and Guinea Bissau, which has enabled us to further define the data for these countries. For this reason you are requested to email comments to: spatialanalysis@unep-wcmc.org.

Key to the maps

Designated marine protected areas

- Nationally designated

Internationally recognised

- Wetland of International Importance (Ramsar)
- World Heritage Site - Natural
- UNESCO-MAB Biosphere Reserve
- Mangrove
- Rivers
- Water bodies

Bathymetry

Bathymetric lines indicate depth (m)

- Low
- High

Human Development Index (HDI) 2003

- 0.8 - 1.0
- 0.6 - 0.8
- 0.4 - 0.6
- 0.2 - 0.4
- 0.1 - 0.2
- 0.0 - 0.1

Population density

- High : 133046
- Low : 0

A Continental Overview

African Countries possessing mangroves (Sub-Saharan)	26
Number of mangrove species in Sub-Saharan Africa	17
Total mangrove area [km²]	34 266
Percentage of global mangrove cover	19

WHAT ARE MANGROVES?

Mangroves are unique plants that have evolved to survive in the interface between land and ocean in the humid climate of the tropics and subtropics. They are variously described as coastal woodland, tidal forest and mangrove forest and grow as trees up to 40 metres high or as shrubs below the high-water level of spring tides. They have evolved clever mechanisms to enable them to cope with the high concentrations of salt and regular inundation of their root systems by incoming tides. Mangroves require freshwater inflow, which brings silt with it as substrate for support and nutrients from upstream. Mangroves do not thrive in stagnant water (FAO, 1994; Kathiresan and Bingham, 2001; AFROL, 2002).

Mangrove forests provide habitat to a variety of flora and fauna. The term mangal was proposed in 1968 by McNae to describe the wider forest community, where as the term "mangrove" is used to refer to true mangrove species. This definition is used for this report.

STATUS AND DISTRIBUTION

Globally, there are 70 species of true mangrove recorded (Spalding *et al.*, 1997), of which 17 species exist in 26 countries of Sub-Saharan Africa. African mangroves are widespread along the west coast from Senegal to the Congo, and occur locally in East Africa, interlinked with highly productive coastal lagoons, tidal estuaries and deltas. They provide these areas with essential organic nutrients as well as critical breeding grounds and nurseries for larval and juvenile stages of important fisheries species (Shumway, 1999). Global data on mangroves report that 19 per cent of mangrove habitat is currently contained within designated protected areas (Chape *et al.*, 2005).

WHY ARE MANGROVES IMPORTANT TO HUMAN WELL-BEING IN AFRICA?

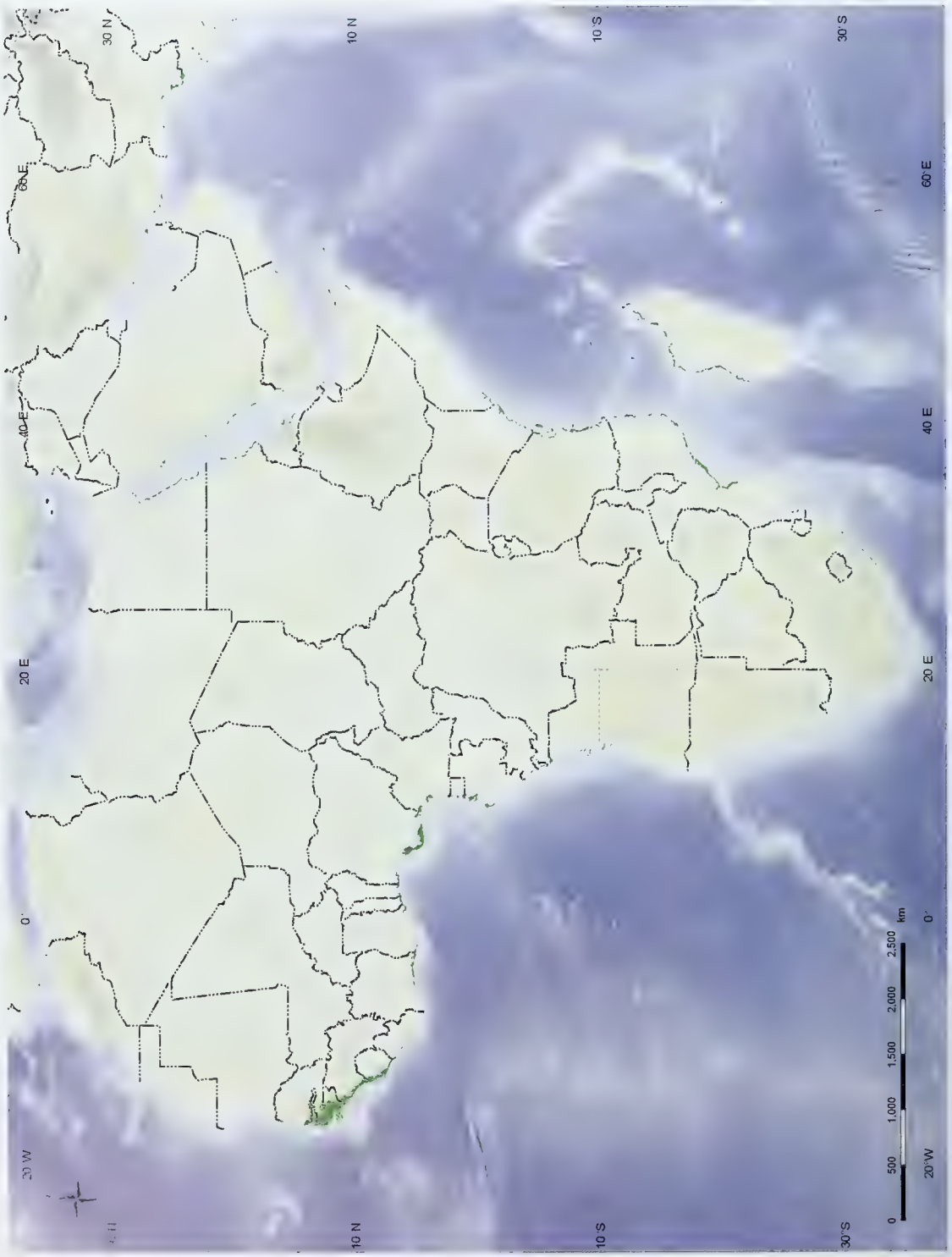
Historically mangroves have been regarded as swampy, mosquito-infested, muddy wastelands and have in the past been cleared in the interest of public health (AFROL, 2002) or for conversion into other uses for high profit but short-term gains. However, it has emerged that mangroves are among the most productive terrestrial ecosystems and are a natural, renewable resource (FAO, 1994).

Throughout Sub-Saharan Africa, the livelihoods of coastal populations depend heavily on access to natural resources. Mangroves fulfil important functions in terms of providing wood and non-wood forest products, coastal protection, conservation of biological diversity, provision of habitat, spawning grounds and nutrients for a variety of fish and shellfish, and salt production. Mangrove forests provide the nutritional inputs to adjacent shallow channel and bay systems that constitute the primary habitat, spawning and breeding grounds for many aquatic species of commercial importance (NOAA/NOS, 2002).

The Millennium Ecosystem Assessment categorized environmental services into four categories (UNEP, 2006). Examples of the services relating to mangroves are:

1. *Regulating:* Shoreline protection – the complex three-dimensional structure of a 200m band of mangrove branches, trunks and roots can absorb 75 per cent of the energy generated by wind-generated waves (UNEP-WCMC, 2006a); atmospheric and climate regulation; human disease control; water-processing; flood control; erosion control;
2. *Provisioning:* Use of timber for fuel (cooking, fish processing, salt production); charcoal; construction; thatch; feed; fruits; fishing; gleaning for shellfish; and extraction of chemicals (e.g. tannins, saponins, alkaloids, flavonoids) for craft and medicines; glues;
3. *Cultural:* Amenity; recreational/tourism of mangroves is not yet well developed (except in some areas of Angola), but is being explored elsewhere in the world; taboo/sacred areas; education and research;
4. *Supporting:* Cycling of nutrients; fish nursery habitats; sediment trapping; filtering of water; treatment of waste (e.g. sewage); biochemical; absorbing toxins;

A recent estimate suggests that the annual values of the benefits and services provided by one kilometre of mangrove range from US$ 200 000 to 900 000 (UNEP-WCMC, 2006a).



Map 1. Distribution of mangroves of Africa

There is a high uncertainty attached to these values, but they provide some indication of the value of the ecosystem

There is a call for the connections between mangroves and livelihoods throughout Africa to be strengthened at the policy level. With high coastal populations, rapid urban growth and a high dependency of coastal populations on fish for protein, fuel, timber and rice production, pressures on mangroves are high. There is concern that the long-term values of intact and functioning ecosystems are not being recognized in current policy decisions, where short-term gain resulting in loss of the ecosystem is being pursued at the expense of long-term sustainability. An estimated 70 per cent of mangroves in Africa will be deforested if no action is taken (World Bank, 1994).

Box 1: Rice-Fish Mangrove Farming

The Portuguese were probably the first Europeans to visit the mangrove forests of the Indian Ocean in the 14th century, where they learned the traditional Indian technique of rice-fish mangrove farming. Some six centuries ago, this Indian technology was transferred by Jesuit and Franciscan Fathers to the African countries of Angola and Mozambique (Vannucci, 1997; Kathiresan and Bingham, 2001).

Rhizophora species are especially well utilized as they are rich in tannin and burn almost smokelessly, imparting a pleasant taste to cooked food.

ASSOCIATED BIODIVERSITY

Seventeen true mangrove species are found in Africa (see Table 1). There are a number of problems with mangrove taxonomy and many of these arise from hybridization between described species (Kathiresan and Bingham, 2001)

Mangroves have broader ranges and are more diverse along the warmer eastern coastlines of the Americas and Africa than along the cooler western coastlines (Kathiresan and Bingham, 2001). Eight species are represented in mangrove forests of West Africa, with nine found in East Africa (UNEP-WCMC, 2003; FAO, in press). The species composition of West African mangroves is similar to mangroves of the Americas, whereas those of East Africa are similar in species composition to those in the rest of the Indian Ocean (WWF, 2001; FAO, in press).

Mangrove forests are rich in biodiversity, providing habitats for a host of animal species from endangered mammals to reptiles, amphibians and birds, and spawning grounds for a variety of fish and shellfish, including several commercial species. Mangrove forests also provide nutrients to coastal marine waters, often resulting in high fisheries yields in waters adjacent to them (UNEP-WCMC, 2006a).

THREATS AND DRIVERS OF CHANGE

Rivers are dammed, their waters diverted and the intertidal zone extensively developed for agriculture or aquaculture, resulting in the destruction of mangrove forests. Large tracts of mangrove forests have also been converted to rice fields, fish and shrimp ponds, industrial, urban and tourism development and other non-forest uses. Mangrove areas are

Emily Corcoran

further exploited for fuelwood and charcoal. In overpopulated and acute fuelwood-deficient areas, even small branches and saplings are removed primarily for domestic fuel (FAO, 1994; FAO, in press). Salt is produced by villagers by boiling brackish water in clay bowls over fire made from *Avicennia;* this technique requires seven tonnes of wood to produce one tonne of salt (Bandarayake, 1997), so places a heavy demand on the mangroves. On a larger scale, salt is harvested from evaporation ponds or shallow brine-filled pits, usually built in cleared mangrove areas (UNEP-WCMC, 2003). The mangroves in West Africa also face many of the conservation and development challenges emblematic of the continent as a whole, as will be shown in the next chapter. Four major drivers of change can be identified across the continent:

(1) Population growth and urban development in the coastal zone:

In the tropics, human populations are concentrated around coral reefs and mangroves, with 64 per cent of the world's mangroves occurring within 25 kilometres of major urban centres with populations of over 100 000 (UNEP-WCMC, 2006a).

Mangrove wood is a principal resource for coastal communities throughout Africa, but it is heavily affected by current patterns of demographic growth and urban development in the coastal zone. The problem is compounded by high levels of poverty, reducing purchasing power of consumers who are unable to pay for modern energy and turn to mangrove wood as a source of energy (Nicole *et al.*, 1994; Saenger and Bellan, 1995).

Mangrove deforestation in Africa continues, though at a slightly lower rate in the 1990s than in the 1980s (FAO, in press). Such deforestation results in a loss of habitat and species diversity of mangroves and the associated species and indeed ecosystems, such as seagrass beds, coral reefs and other coastal systems. For example, declines in the production of demersal species along the Coast of Guinea are generally the result of a loss of mangroves, pollution and overfishing (Shumway, 1999).

(2) Economic and political trends

Towards the end of last century, several African countries were struck by serious economic crises, which resulted in high levels of unemployment and widespread poverty. In the coastal cities, the trade of wood coming from the mangroves has been a flourishing activity. With the modernization of the cutting materials by the introduction of slicers and large dugouts propelled by engines (Din and Blasco, 1998), harvesting has become more efficient, exacerbating this situation (Din, 2003).

Complex and unclear land-tenure systems make management difficult to implement in many parts of Africa (Said, 2007).

Strategies to increase food security in many countries involve the expansion of rice production in mangrove areas, which causes a significant loss of mangroves across Africa (Said, 2007).

(3) Climate change

The response of mangroves to climate change is a worldwide concern from both scientific and policy

Emma Greatrix/Wetlands International

Table 1: True mangrove species present across Africa

Region	Countries in Analysis	Associated mangrove species
West Africa (8)	Angola, Benin, Cameroon, Congo, Côte d'Ivoire, Democratic Republic of the Congo, Equatorial Guinea, Gabon, Ghana, Guinea, Guinea Bissau, Liberia, Mauritania, Nigeria, Sao Tome and Principe, Senegal, Sierra Leone, Gambia, Togo	*Acrostichum aureum* *Avicennia germinans* *Conocarpus erectus* *Laguncularia racemosa* *Nypa fruticans* *Rhizophora harrisonii* *Rhizophora mangle* *Rhizophora racemosa*
East Africa (9)	Kenya, Madagascar, Mozambique, Seychelles, Somalia, South Africa, Tanzania	*Avicennia marina* *Avicennia officinalis* *Bruguiera gymnorrhiza* *Ceriops tagal* *Heritiera littoralis* *Lumnitzera racemosa* *Rhizophora mucronata* *Sonneratia alba* *Xylocarpus granatum*

perspectives. However, most studies have only assessed the impacts of sea level rise (Ellison and Farnsworth, 1997; Blasco *et al.*, 2001; McLean *et al.*, 2001). There is concern about the potential obstacle that hard protection structures such as dykes could constitute to the horizontal migration of mangroves (Viles and Spencer, 1995; Nicholls, 2004). The effects of climate change have been felt across the West African region as a whole and need to be taken into account in any management strategies that are implemented.

It is expected that changes in the climate could result in increased frequency of storm surges (UNEP-WCMC, 2006a).

(4) Changes in upstream habitat

Increases of pollution or toxic influxes; changes in the freshwater regimes, such as flood regimes (e.g. in the case of the damming of the river Volta); upstream deforestation and increased sediment run-off.

Are mangroves protected in protected areas?

In Africa, 14 per cent of the area identified as mangrove falls within designated national and international protected areas. It has been suggested, however, that currently only a fraction of the designated protected areas is actively managed. An analysis of uses and threats to mangroves within Ramsar sites in western and eastern Africa suggested poor status of management effectiveness due to financial and administrative constraints, and to the high levels of poverty in and around the protected areas are of major concern (Ramsar, 2006b). The following is a list of uses identified inside Ramsar sites in Africa, which reflects the situation found outside of protected areas:

- Subsistence and commercial fishing;
- Permanent and shifting arable agriculture, agricultural run-off, rice-growing;
- Fire wood/non-timber forest product collection, commercial-scale forest exploitation;
- Salt production;
- Sand/gravel extraction;
- Poaching/excessive hunting of species;
- Urban development;
- Overgrazing by livestock;
- Infrastructure development;
- Mining exploitation;
- Dam impacts;
- Industrial pollution;
- Expansion of settlements;
- Exotic/invasive plant species colonization.

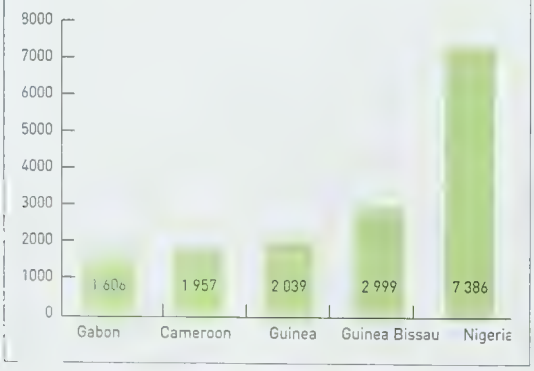
Regional Overview

Land area [km²]	7 898 180
Coastline [km]	22 613.40
Average population density [per km²]	59.31
Average population growth rate [%]	2.37
Number of mangrove species in country	8
Total mangrove area [km²]	20 144
% of African mangrove cover	59
% of global mangrove area cover	11
Estimated change 1980–2006	Moderate decline
Mangrove area falling within protected areas [%]	18

STATUS

Mangroves occur in 19 West African countries from Mauritania in the north with the southernmost stands in Angola (UNEP-WCMC, 2006b). Interestingly, the origins of the term for mangrove are derived from the word *mangue*, which comes from Senegal, Gambia and Guinea (Vannucci, 1989). Nigeria contains the most extensive mangrove ecosystems, which comprise nearly 35 per cent of the total cover for the region (UNEP-WCMC, 2006b). Figure 1 shows the five countries containing the largest amount of mangrove cover in West Africa.

Figure 1: Total mangrove area of the five countries in West Africa containing the largest coverage of mangroves, km².



Regional conditions enable mangroves to grow as far as 100 kilometres inland, due to strong tidal influences on rivers such as the River Gambia, the Sine-Saloum in Senegal, the Casamance, Guinea Bissau, River Niger and Cameroonian rivers. Similarly, where there are strong riverine influences into the seas, islands affected by freshwater influxes provide an environment for mangrove growth; for example, the Bijagos Archipelago of Guinea Bissau (AFROL, 2002).

This report presents a profile for each of these 19 countries, considering mangrove status, distribution, biodiversity, uses, threats and drivers of change. Although there is considerable work being undertaken to research this habitat at the national, regional and global level, (e.g. Spalding *et al.*, 1997; forthcoming *Revised World Atlas of Mangroves*) there are still significant gaps in information, with a need for continued efforts to improve assessment in the region.

The overall trend for the region using area estimates from 1980 to 2006 indicates a moderate decline of mangrove cover. Four countries appear to have an increase in mangrove area; two a slight decline; nine countries moderate decline and three countries (Congo, Côte d'Ivoire and Democratic Republic of the Congo) show a severe decline in mangrove habitat.

BIODIVERSITY

Eight true mangrove species are found in West Africa (Tomlinson, 1986). These are listed in Table 2 with descriptions for each provided in Annex 3. The distribution of species by country and summary of the number of species per country is shown in Table 3.

West Africa has fewer true mangrove species than East Africa, but it has more extensive mangrove coverage due to the extensive riverine systems not present in the east (Shumway, 1999). There is no overlap between the species observed in East and West African mangroves. West African mangroves are also remarkable for supporting some Indo-Pacific lineages of fish in the Atlantic Basin, such as the mudskipper (Kaufman, n.d.).

Mangroves in the region are considered very rich in biodiversity. The excess organic production of mangroves is exploited by many marine species, especially fishes and crustaceans that enter the mangrove environment as juveniles and return to the sea as adults for reproductive purposes (John and Lawson, 1990).

Table 2: Scientific and common names of West African mangrove species

Scientific Name	Common Name
Acrostichum aureum	Golden Leather Fern
Avicennia germinans	Black Mangrove
Conocarpus erectus	Buttonwood Mangrove
Laguncularia racemosa	White Mangrove
Nypa fruticans	Mangrove/Nypa Palm
Rhizophora harrisonii	Red Mangrove
Rhizophora mangle	Red Mangrove
Rhizophora racemosa	Red Mangrove

MAIN USES OF MANGROVES AND ASSOCIATED ECONOMIC ACTIVITY

Aquaculture – not particularly developed in West Africa.

Ecotourism – whilst this report has found that there is still little evidence of ecotourism in West Africa, it is starting to develop in Senegal (Petit Côte, Siné-Saloum) and Gambia is targeted for future potential (Said, 2007). There has been some such development in other African countries.

Fisheries – fish are a major source of dietary protein in the region, more than five million people in the region are dependent on small-scale fisheries for their livelihoods (SFLP, 2000). In addition to capture fisheries, "Acadja" or the brush park system is also practised in West African lagoon systems. This is a traditional method of fishing that involves setting up artificial habitats in the middle of lagoons using tree branches (frequently mangroves). Another characteristic of artisanal coastal fishing in West Africa is seasonal transboundary migration, following fish stocks along the coast, causing conflict with resident fishing populations, and affecting the methods used when away from their home country.

Gleaning – of shellfish and other aquatic species; for example, oysters and crabs.

Hunting and harvesting – of non-aquatic animals inhabiting mangrove forests and harvesting of edible components of mangrove and non-mangrove plants.

Table 3: Distribution of mangrove species throughout West Africa

Country	*Acrostichum aureum*	*Avicennia germinans*	*Conocarpus erectus*	*Laguncularia racemosa*	*Nypa fruticans*	*Rhizophora harrisonii*	*Rhizophora mangle*	*Rhizophora racemosa*	Total Species
Angola		X					X	X	3
Benin	X	X	X	X		X		X	6
Cameroon		X	X	X		X	X	X	6
Congo	X	X	X	X		X		X	6
Côte d'Ivoire	X	X	X	X				X	5
Congo (DR)	X	X	X	X			X	X	6
Equatorial Guinea		X						X	2
Gabon	X	X	X	X		X	X	X	7
Ghana	X	X	X	X		X		X	6
Guinea	X	X	X	X		X	X	X	7
Guinea Bissau		X	X	X		X	X	X	6
Liberia	X	X	X			X	X	X	6
Mauritania		X	X					X	3
Nigeria	X	X	X	X	X	X	X	X	8
Sao Tome & Principe	?	?	?	?		?			4?
Senegal	X	X	X	X		X	X	X	7
Sierra Leone		X	X	X		X	X	X	6
The Gambia	X	X	X	X		X	X	X	7
Togo		X	X					X	3

Table 4: Examples of medicinal uses of mangrove and mangrove extracts in West Africa.

Species	Use
Rhizophora racemosa	Roots: used with palm oil as an ointment for boils. Bark: extract used for fungal infections of the skin; treatment of diarrhoea and dysentery in children; leprosy; sore throat.
Avicennia germinans	Leaves: ashes used as a salt substitute. Bark: powdered bark mixed with palm oil for treatment of lice, ringworm and mange. Seeds: germinating seeds used as a poison.
Conocarpus erectus	Leaves: decoction used as a febrifuge. Latex: applied to cuts to stop bleeding. Roots: ground and boiled as a cure for catarrh. Bark: used in the treatment of gonorrhoea.

Source: Gordon, 2005

Medicinal uses – mangroves are used for a number of medicinal purposes. Some examples are provided in Table 4, above.

Non-use value – mangroves in the region have rich cultural and spiritual value, they provide environments for many rare and endangered species such as the African Manatee, and are nursery habitats for many fish species.

Oil exploration and production – more than 90 per cent of oil-related activities take place in the Niger Delta as it is the area of the West African coastline richest in mineral resources, attracting significant international investment. In 2006, the state-owned China National Offshore Oil Corporation paid US$ 2.3 billion for a stake in a Niger Delta oilfield, an area rich in mangroves. This is China's largest single investment in Africa to date (Ekweozor, 1989; CNN, 2006). Exploration for new oil fields continues throughout the region, and is likely to be an increasing issue.

Timber usage – the timber of mangroves is used widely in the region, and markets for its trade are well developed. As mangroves are the main forest trees in many of the coastal zones in which they occur, they are exploited for domestic fuel, fish-processing, salt production, construction of boats, houses and fences as well as production of tools.

Salt production – is an important industry, in particular in the lagoon systems between Côte d'Ivoire and Benin. In Ghana, for example, large-scale commercial salt production for export is an important economic activity in coastal wetlands (NOAA/NOS, 2002). In the Republic of Guinea, much of the salt consumed is from local coastal production (Said, 2007).

THREATS AND DRIVERS OF CHANGE

(1) Population growth and urban development in the coastal zone

The Atlantic corridor has some of the highest centres of

Case Study: Oil and beyond in the Niger Delta

The impact of oil exploration in the Niger Delta is not restricted to oil pollution alone. The development of oilfield infrastructure requires extensive land clearance, dredging and sand filling in the mangrove areas. During dredging, the soil, sediment and vegetation along the route of the proposed site are removed and in most cases deposited on the mangroves fringing the banks. The abandonment of the resulting dredged material has caused a number of impacts including smothering of fringing mangroves, alteration of the surface topography and hydrology, acidification and water contamination, all of which can result in vegetation damage and fish kills. Consequently, former mangrove areas have been converted to either bare land, grassland, or, eventually freshwater forest after several years of natural weathering. The impact of dredging on mangrove is far-reaching, because it affects many components of the ecosystem including mangrove vegetation, benthic invertebrates, fisheries, plankton, wildlife, soil, sediment and water quality and therefore the well-being of the communities that live in the area and who depend directly on the rich biodiversity of the mangrove ecosystem for their livelihoods (Ohimain, 2001; 2003; 2004; Ohimain *et al.*, 2002; 2005).

Emma Greatrix/Wetlands International

population density in Africa (see Map 2a) (Dakar, Abidjan, Accra-Tema, Cotonou, Lagos, Port Harcourt, Douala and Libreville) due to high intrinsic rate of growth (NOAA/NOS, 2002). Between Senegal and Nigeria an estimated 60 million people, representing 25 per cent of the population, live within 60 kilometres of the coast, a narrow belt accounting for less than 10 per cent of the landmass of these coastal countries, (NOAA/NOS, 2002). In Nigeria, for example, about 20 million people (22.6 per cent of the national population) live along the coastal zone; and about 4.5 million Senegalese (66.6 per cent of the national population) live in the Dakar coastal area (IPCC, 2000). In addition, about 60 per cent of the industries in West Africa are located in coastal cities (NOAA/NOS, 2002).

This rapid development is placing growing pressure on coastal natural resources, often regarded as open-access resources. Immigration and deepening poverty in rural communities have led to the exploitation of these resources for subsistence, and by industries (e.g. forestry and fisheries sectors), which have taken advantage of poor management and legislation (World Bank, 1994). Map 1b shows mangrove cover overlaid with the Human Development Index. The majority of West African countries are among the least developed countries, according to the UNDP, whose populations have a characteristically high dependency on natural resources. Mangrove forests are logged to supply wood for fuel and construction, and they are exploited for oil exploration and drilling. Illegal and unregulated fishing techniques that use poison and dynamite further undermine the structure and function of mangrove ecosystems. Waste that results from these developing urban centres, such as sewage, litter and chemical pollutants are contaminating the waters that provide valuable breeding grounds for commercially important fish (National Geographic, 2001).

As mangroves are removed to create space for building, the services that the mangroves provide are also removed, including their ability to trap sediment and stabilize the coastline. In the Niger Delta, mangrove deforestation has resulted in serious erosion and flooding, destroying fishing villages along the coast as the shorelines become exposed to wind and wave erosion (Shumway, 1999).

All countries in the region are in the process of preparing Poverty Reduction Strategy Papers (PRSP) in association with the World Bank, in effect, national strategies for the alleviation of poverty. It is clear that where they exist, and almost without exception, mangroves are heavily depended on by the poor and marginalized communities of West Africa, and their sustainable use is essential. Mangroves are only mentioned in two PRSPs, however, those for Nigeria and Sierra Leone. Nigeria alone currently calls for conservation of mangroves as unique habitats for sustaining livelihoods (Nigerian National Planning Commission, 2004).

(2) Economic and political trends

The region has been fraught with civil and political unrest

over the past decades. Throughout the region, many nations are now emerging from civil wars, and levels of poverty are amongst the highest in the world. In times of conflict, priorities for both government and the population change and tend to focus on the short term. This has driven deforestation in some countries such as Liberia and Sierra Leone (WRI, 2003a). The mangrove forests also provide refuge for displaced or fleeing communities. After the conflict ends, governments need to jumpstart the economy and rebuild key sectors. Again, one of the quickest ways to do this is to exploit natural resources, and in this region, mangroves form key forestry resources in the heavily populated coastal zones. Military and militia activity also reduce opportunities for research and conservation of these areas, for example in Angola, Cameroon, Nigeria and Senegal (Din, 2003).

Exporting oil from coastal areas is an economically important activity in Nigeria, Gabon and Cameroon, but has associated ecological and political risks. It can lead to spills (NDES, 1997), which pose a significant threat to the health of mangrove ecosystems. In Nigeria, during the past 30 years, seismic lines have been placed in the Niger Delta mangrove forests (Elijah, 2001) making this ecosystem and others like it vulnerable to impacts by petroleum and its products (Ekweozor, 1989). Other threats include the gas flaring, canalization, siltation, sand mining and construction of embankments (Ekweozor, 1989; Isebor and Awosika, 1993).

There is much interest in identifying new sources of oil in the continental shelf of western Africa. Activities relating to prospecting also involve risk associated with the studies, residual waters, accidental spill and impacts of installations. It is also critical to note that many countries in the region are not yet signatory to relevant international agreements for the protection of their marine and coastal environments, such as the International Convention for the Prevention of Pollution from Ships (MARPOL) or the United Nations Convention on Law of the Sea (UNCLOS), representing an area of particular potential concern with respect to the marine ecosystem services (Said, 2007).

Box 2: Examples of activities to combat threats to mangroves in West Africa

Mangrove restoration efforts have been conducted in almost all the coastal nations along the Gulf of Guinea. For example:

Gulf of Guinea Large Marine Ecosystem Project from 1995 to 2000 undertook pilot mangrove restoration projects facilitated by NGOs in Côte d'Ivoire, Ghana, Togo, Benin, Nigeria and Cameroon. The project was interdisciplinary in nature, dealing with fisheries ecology, physical environmental processes in the Gulf of Guinea, and human dimensions, such as pollution, socio-economic management aspects and governance.

The project is based on the fact that marine pollution and living marine resources respect no political boundaries and therefore require a large-scale concerted and holistic approach for assessment and control (UNEP-GPA, 2006).

The Lower Volta Mangrove Project, supported by the UK, included pilot restoration activities in Ghana. Overexploitation for use as domestic fuelwood and in the smoking of fish are believed to have caused severe degradation of these resources. It seeks to develop landowner- and community-based approaches for the rehabilitation and long-term sustainable use of mangrove resources in the Volta River estuary area.

The project conducted baseline maps of vegetation, analysis of changes over time, description and analysis of past and present management regimes and analysis of the social and economic significance of the mangrove ecosystem to the local populations. For sustainability, it has a capacity-building component, which trains Ghana Wildlife Department staff to undertake studies independently (DFID, 1996).

Community restoration in Ghana (A.K. Armah): Two communities undertook mangrove restoration projects of degraded areas with the assistance of the NGO, *Resource & Environment Development Organisation* (REDO) and the Forestry Department at Winneba. The project was funded by the Netherlands Committee of the International Union for Conservation of Nature for three years (1997–2000). It achieved the planting of 6000 propagules; planting of two sustainable plots of 10 000 *Cassia* trees as an alternative source of fuel and wood; education and awareness-raising within communities about the importance of mangroves and forest conservation, particularly with schoolchildren and community leaders. The project encountered a particular problem of fires after poor rains, which adversely affected the number of Cassia plants planted in the first year of the project. The remarkable ability of *Cassia* to regenerate after fires minimized any damage that the plants would have suffered. The project has brought a halt to mangrove harvesting in the two communities and community members now rely on the *Cassia* and other terrestrial species.

3) Climate change

West Africa is considered to be one of the regions of the world most vulnerable to climate change (Niasse, 2002) and, since climate change impacts are likely to increase in the future, these are likely to affect mangrove distribution patterns. Weather patterns and changes in the strong currents and upwellings that characterize the region (the Benguela, Guinea and Canary Currents) will bring about the greatest changes to mangrove distribution patterns. The region has experienced a marked decline in rainfall since 1968–1972, from 15 to 30 per cent, depending on the area. The region's major rivers (Niger, Senegal, Volta) experienced concomitant decrease in average discharge from 40 to 60 per cent (Niasse, 2005). Over the past 50 years, high climate variability has been associated with increased desertification and food insecurity in the West African region (Niasse, 2002).

In addition to the changes in rainfall, climate change is also expected to affect atmospheric pressure, temperatures, evaporation, hydrological regimes, sea level, magnitude and frequency of storms and carbon dioxide concentration. These changes, together with current decline in mangrove cover and the discussed anthropogenic impacts, can only exacerbate the current situation. It is worth noting that the carbon content of the ground in mangrove forests is 4–18 times higher than the carbon content of tropical rainforests (Fujimoto, in press). Positive management, conservation and rehabilitation could contribute substantially to the sequestration of carbon dioxide (Baba, 2004).

There are likely to be both positive and negative affects on mangroves as a result of climate change, although it is uncertain exactly what the outcomes will be as local variability will be high (UNEP-WCMC, 2003). The balance between anthropogenic pressures, sedimentation and erosion as well as the rate of sea-level rise will be crucial as to how mangroves respond to climate change (Nyong, 2005).

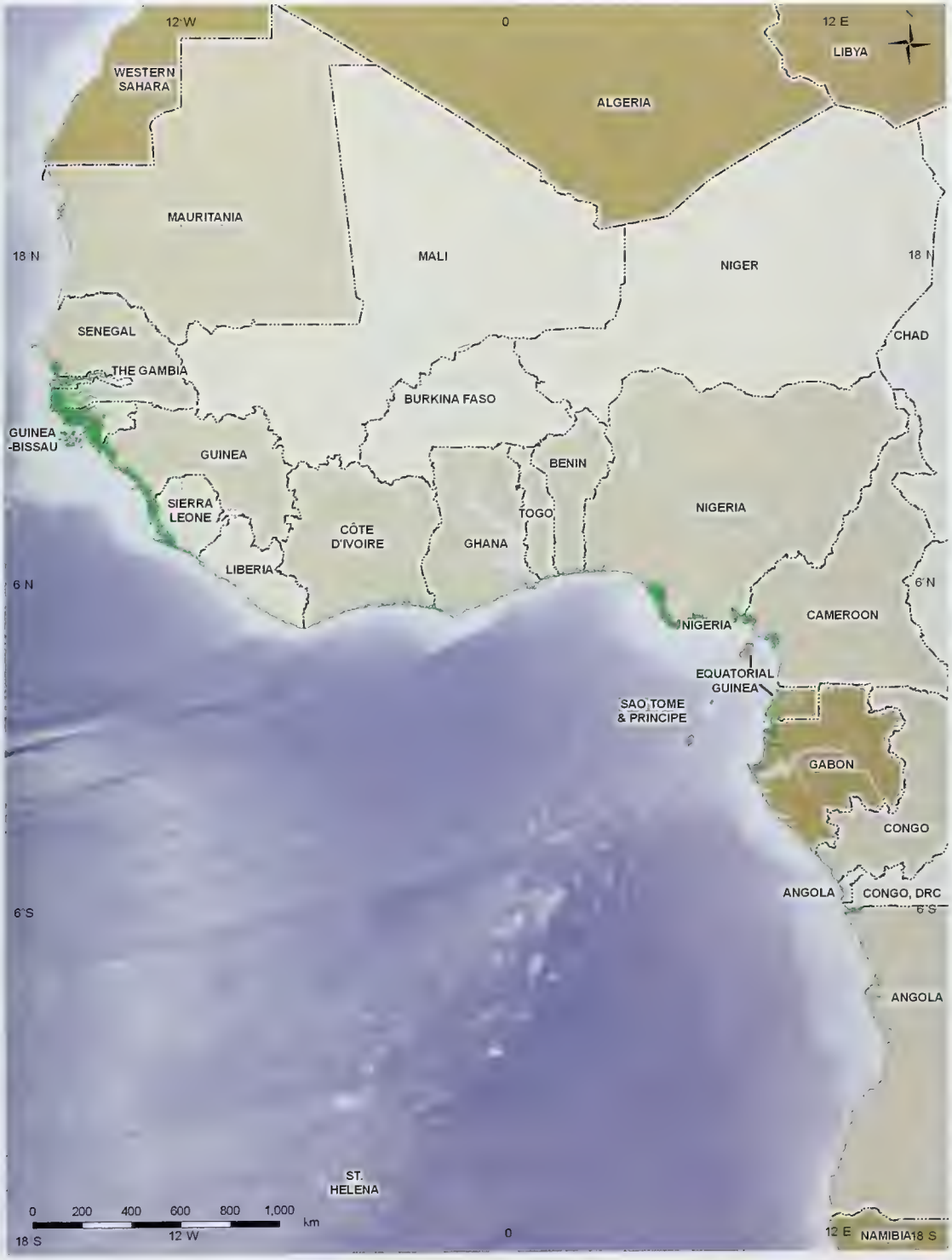
Summary list of threats to mangroves in West Africa identified in this report

Agriculture and aquaculture (rice, shrimp, fish)
Construction of access roads
Construction of embankments
Desertification
Fuelwood and charcoal
Hydroelectric projects
Land-based sources of pollution
Oil exploration, drilling and production
Rubbish dumping
Sand mining
Sewage and pollution
Unsustainable gathering, fishing and hunting
Urban and tourism development
Water diversion for agriculture and aquaculture

(4) Changes in upstream habitat

Any beneficial effects on marine fisheries of the net energy outflow from mangroves are at risk from anthropogenic influences along the coast or further inland that cause pollution or destruction of the mangrove ecosystem (John and Lawson, 1990). One of the major activities taking place in close proximity of mangroves and encroaching on mangroves is intensive agriculture (AFROL, 2002). The strong current regimes of the Gulf of Guinea can also carry oil pollution, toxic and solid waste from point sources upstream to other coastal countries, creating region-wide impacts (Shumway, 1999).

Map 2a. Mangrove cover in relation to population density



Map 2b. Mangrove cover in relation to the United Nations Human Development Index (2003)

17°W
16°W
15°W
N
16°31'12"W
16°28'48"W
19°24'0"N
19°N
19°21'36"N
19°21'36"N
16°31'12"W
16°28'48"W
16°24'0"W
16°21'0"W
19°51'0"N
19°51'0"N
19°48'0"N
19°48'0"N
16°24'0"W
16°21'0"W
18°N
18°N
16°30'W
16°21'0"W
16°12'0"N
MAURITANIA
MAURITANIA
16°3'0"N
16°3'0"N
SENEGAL
17°N
17°N
15°54'0"N
16°30'W
16°21'0"W
SENEGAL
16°N
16°N
0 15 30 45 60 75
km
17°W
16°W
15°W

Mauritania

Land area [km²]	1 025 220
Coastline [km]	1 268.4
Population ['000]	3 069
Population density [per km²]	3
Annual population growth rate [%]	2.75
Number of mangrove species in country	3
Total mangrove area [km²]	2.09
% of African mangrove cover	<0.1
Estimated change 1980–2006	Increase
Mangrove area falling within protected areas [%]	62.5

STATUS

Table of mangrove area estimates

Source Year	1980	1990	1997	2000	2005	2006
Area [km²]	1.5	1.1	1.04	1	1	2.09

Mauritania is dominated by desert conditions and correspondingly the mangrove ecosystems are of limited extent and are some of the most arid of the Atlantic African coast (FAO, in press). They are found in the Senegal Delta and in the north, close to Cape Timirist. The two areas are separated by a long stretch of exposed sandy beaches (FAO, in press).

Three Ramsar sites containing mangroves have been designated in Mauritania: the National Park Banc d'Arguin, designated on 22 October 1982 covering an area of 12 000 square kilometres (06°45'N 011°13'W); Diawling National Park, designated on 23 August 1994 covering an area of 156 square kilometres (16°22'N 016°23'W), and Chat Tboul, which was designated on 11 October 2000 and covers 155 square kilometres (16°33'N 016°24'W).

BIODIVERSITY

Three of the eight mangrove species found in West Africa are present in Mauritania:

Avicennia germinans
Conocarpus erectus
Rhizophora racemosa

Rhizophora racemosa develops on the rivers and is dominant in the Senegal Delta; *Avicennia germinans (syn. Avicennia africana)* and specimens of *Conocarpus erectus* are found on the marshes (FAO, in press). In the north, a stand of white mangrove swamp (*Avicennia africana)* is found on the muddy banks of the Ile de Tidra and a patch in bays on the mainland near Cap Timiris. These mangrove stands are the most northerly in the eastern Atlantic, dating from the time when coastal Oueds carried fresh water from the Sahara (Ramsar, 2004). There is very high productivity of pelagic phytoplankton offshore from these mangrove stands and of benthic forms near the shore that provide the energy base for the countless numbers of birds and fish (UNEP-WCMC, 2002).

The National Park Banc d'Arguin gives a glimpse into Mauritania's often surprising biodiversity. The park occupies two thirds of the northern half of the Mauritanian coast (Dahdouh-Guebas and Koedam, 2001) and is a unique example in Africa of a transition zone between the Sahara Desert and Atlantic Ocean. It is a gulf nearly 300 kilometres long with a gently sloping coastline of sand dunes, marshes and mangrove swamps, tidal mudflats, mazes of channels and creeks, sandbanks and islets (UNEP-WCMC, 2002).

Of the estimated seven million shorebirds that use the Atlantic flyway, approximately 30 per cent winter at Banc d'Arguin. It has the world's largest concentration of wintering shorebirds and about 15 species of nesting piscivorous birds (Hoffmann, 1988). At least 249 bird species have been recorded, from both Palaearctic and Afro-tropical realms, several species from each being at the limits of their distribution (IUCN/WWF, 1989). Wintering shorebirds number over two million and include the black tern *Chlidonias nigra;* greater flamingo *Phoenocopterus rubber;* the ringed plover *Charadrius hiaticula;* grey plover *Pluvialis squatarola;* knot *Calidris canutus;* redshank *Tringa totanus* and bar-tailed godwit *Limosa lapponica,* among many other species (Ramsar, 2004; UNEP-WCMC, 2002).

THREATS AND DRIVERS OF CHANGE

Key drivers of change in Mauritania: population increase; climate change.

Overexploitation of mangroves at the local level for firewood and construction of boats.

Desertification and reduced floods caused by the Sahelian drought have increased pressure on land for grazing of camels and goats; persistent drought and mining exploitation also endanger mangroves (Ramsar, 2006b).

Habitat modification: an increase in the salinity of the river basins caused by the construction of the Diama Dam close to the mouth of the Senegal River (FAO, in press).

Increased fishing pressures from overfishing by international industrial-scale exploitation of the Banc outside the park and by neighbouring pirate fishing fleets within the park. In 2001, 334 foreign trawlers had permits to work in Mauritanian waters (AFROL, 2002). Foreign trawlers in these waters take half a million tonnes of fish each year (Pearce, 2001).

Threats observed within the sites of both Parc National du Diawling and Chat Tboul include: agricultural runoff, dam impacts, infrastructure development, tourism-based disturbance, agricultural development impacts, habitat loss, and grazing encroachment (Ramsar 2006b).

ECONOMIC ACTIVITY ASSOCIATED WITH MANGROVES

Economic activities associated with mangroves of Mauritania are predominantly subsistence, and include collection of non-timber forest products, cutting/collection of firewood, charcoal production, and shifting and permanent arable agriculture (Ramsar, 2006b). Commercial fishing takes place offshore from the mangroves; these fisheries rely on mangroves as nursery grounds.

Senegal

Land area [km²]	192 530
Coastline [km]	1327.2
Population ['000]	11 658
Population density [per km²]	59
Annual population growth rate [%]	2.30
Number of mangrove species in country	7
Total mangrove area [km²]	1 287
% of African mangrove cover	4
Estimated change 1980–2006	Moderate decline
Mangrove area falling within protected areas [%]	42.5

STATUS

Table of mangrove area estimates

Source Year	1980	1990	1997	2000	2005	2006
Area [km²]	1 690	1 450	1 830	1 270	1 150	1 287

Senegal has unique and well-developed mangrove resources, all of which have suffered some decline since the 1980s. The mangrove flats occur on clay deposits surrounded by rivers and are strongly influenced by the ocean. Mangroves connect with mudflat areas known as *tannes* (barren areas) and form a complex and unique network of habitats. The mangroves tend to form linear bands matching the contours of the tidal channels.

South of the Gambia, mangroves occupy the estuary of Casamance and form an important and particularly dense six-kilometre-wide band of mangrove forest on the northern bank of the river between Ziguinchor and Tobor. This gradually thins out until mangroves appear only on the small islands or in thin curtains along banks to Devil's Island upstream of Sédhiou. On the southern bank of Casamance, the mangrove coverage is less significant, but one can distinguish two substantial stands: the most western is located between Kabrousse and Karabane with an average width of 10 kilometres. The eastern mass is separated from the first by a dry terrestrial zone, and extends from Pointe Saint George at the Guinean border, and then stretches along the Kamabeul River on both sides. Between the rivers Kamabeul and Ziguinchor, the mangrove stands are an average of 1.5–2 kilometres in width. Beyond this, they are present only intermittently in very narrow fringes (FAO, in press).

Small areas of mangrove can be found on the Petite Côte and in the proximity of Somone and Joal. The mangroves of the Sine-Saloum Delta are heavily influenced by the marine environment and stretch for 650 square kilometres around its maze of tributaries (EC, 2003).

Control and responsibility for mangroves falls under three departments within the Ministry of Environment and Protection of Nature. A number of codes contain measures to protect mangrove forests. Senegal has one Ramsar site with mangroves: Delta du Saloum, designated 4 March 1984 and covering an area of 730 square kilometres (13°37'N 016°42'W).

BIODIVERSITY

Seven of the eight mangrove species occurring in West Africa are present in Senegal:

Acrostichum aureum
Avicennia germinans
Conocarpus erectus
Laguncularia racemosa
Rhizophora harrisonii
Rhizophora mangle
Rhizophora racemosa

The Casamance mangroves are made up of two species: *Rhizophora racemosa* and *Avicennia nitida*. The first is a pioneer species and establishes itself on the edge of the backwaters and where the mud is newly deposited. *Avicennia* spp. grows on the more stable, older sediments and constitutes the majority of the mangroves. It invades the abandoned rice plantations, which have been affected by tidal influence. Bushy shrubs, characteristic of the saltier grounds, in particular *Conocarpus erectus*, can be found on the edges of land closest to the mangroves (FAO, in press).

To the north of the Gambia, dense populations of *Rhizophora racemosa* and *Avicennia africana* grow along the Sine-Saloum and between the mouths of the rivers Saloum and Gambia. These mangroves are home to four species of breeding turtles, and numerous species of nesting waterbirds and wintering Palearctic migrants (Ramsar, 2000).

In the far north of Senegal, between the mouth of the river and the island of Thiong, between Loll and Senegal, *Rhizophora racemosa* and *Avicennia germinans* occur, albeit in a poor state as a result of competition with *Halophilous gramineous*, *Sporobulus robustus* and

MAURITANIA
SENEGAL
THE GAMBIA
GUINEA-BISSAU
17°W
16°W
15°W
16°N
15°N
14°N
13°N
16°30'W
16°21'0"W
16°12'0"N
16°3'0"N
15°54'0"N
0 15 30 45 60 75
km

Paspalum vaginatum. The salt meadows that often border the mangroves consist of *Sesuvium, Paspalum, Sporobulus, Scirpus* and *Philoxerus* (FAO, in press).

THREATS AND DRIVERS OF CHANGE

Key drivers of change in Senegal: climate change, population pressures

Since 1963, Senegal has been fighting desertification, which is reducing the total surface area of land suitable for cultivation and production. Resultant intensive agricultural activities and demographic pressure have caused erosion and silting (FAO, in press). The mangrove forest of the Saloum Delta is vital to trap sediments and prevent soils from being washed away; these supply essential nutrients for young fish and shelter oyster colonies. This delta is under threat from coastal erosion and from the salination of the soil (EC, 2003) as well as overexploitation of resources such as oyster and timber (Said, 2007). Inside the Saloum Ramsar reserve, management challenges include illegal gathering of molluscs, birds and turtle eggs, as well as unsustainable exploitation of plant products. Surrounding areas are used for agriculture, livestock rearing, fishing and hunting (Ramsar, 2000). Dependence of communities on mangrove resources is leading to their unsustainable use and overexploitation, in particular of fish and molluscs (Macintosh and Ashton, 2003)

ECONOMIC ACTIVITY ASSOCIATED WITH MANGROVES

Fisheries, tourism and phosphates are the mainstays of Senegal's economy (Macintosh and Ashton, 2003). Fish currently provide 70 per cent of the animal protein consumption in Senegal (Macintosh and Ashton, 2003).

The mangrove areas are traditionally used for rice growing and paddy fields, fishing, aquaculture and the gathering of wood (FAO, in press; Macintosh and Ashton, 2003). The harvesting of mangrove oysters (*Crassostrea gasar*) is an historic practice that was still going on in the Casamance in the late 1980s (Binet *et al.*, 1995). There was a very active trade in dried oysters up to 1950. The harvest was particularly important during the drought years when it was impossible to grow rice. The mangrove trees of the Saloum Delta also provide a stock of medicinal plants used by locals and a significant source of income for the women who farm the shellfish (EC, 2003). The mangrove habitat in the Delta du Saloum Ramsar reserve is used for nature conservation, tourism and pastoralism (Ramsar, 2000). It is thought that eco-tourism might present a strategic option for developing alternative economic activities in the mangroves, based on conservation, restoration and valuing of natural and cultural aspects of the forests (Macintosh and Ashton, 2003). The sustainability of these resources is critically dependent on the continuing health and functioning of the mangrove ecosystems.

Case study: Mangroves and Poverty Alleviation in Senegal
Abdoulaye Diame

Mangroves are a productive ecosystem that supports the livelihoods of communities in Senegal, but mangroves have been lost due to construction of channels, habitat conversion for rice farming and coastal erosion. One unfortunate result of this destruction was rural-to-urban migration, because these once-productive ecosystems no longer yielded sufficient fisheries resources. A reforestation project was undertaken in the Saloum Delta to address these issues.

The project had two components: capacity building to build awareness and train communities in reforestation techniques and training in sustainable oyster harvest techniques.

To date there have been a number of key outcomes:

- 75 hectares of mangroves were reforested;
- *More sustainable use of mangrove resources*, especially by women who are the primary managers and users of mangrove resources;
- *Time saved:* the new oyster-capture technique was less harmful to the oyster population and mangroves, while actually reducing the working time of women who harvest them;
- *Increased fisheries resources:* the populations of molluscs, gastropods, crustaceans and shrimp began to return.

It is hoped that lessons learned from the success of this pilot project may be applicable to other parts of the country.

Source: ISME, 2003

Case study: Equitable Shrimp Culture

Emily Corcoran

"Rehabilitation and integrated management of the resources of wetland communities in the Ramsar site of Saloum Delta" was a test initiative for equitable shrimp trade. It provided small-scale fishermen from eight villages with nets, life jackets and ropes, with the objective to improve and upgrade the utilization of techniques and machines for sustainable fishing and safeguard the resource.

The initiative is partnered by a private company, which buys and transports the produce to its manufacturing unit based at Mbour. The producers are paid direct factory prices, cutting out the middlemen, but at the same time quality control is tight and a high-quality product required. The fishers work together and monitor their performance to ensure that they can retain these direct prices. By removal of the middlemen, the income generated returns directly to the villages in the form of community funds, which facilitate some small development projects at the end of the fishing season. This monetary income has also contributed to the regeneration of the mangrove ecosystem: buying better ovens, for example, reduces the consumption of mangrove wood for smoking fish. The first indications are that this initiative is having some positive impacts, in particular:

(1) the fishermen understood that the mature shrimp are more expensive than the juveniles and consequently regulated fishing gear is used;

(2) working as a community organization pays fishermen more money, which enables them to choose periods of rest and also the resources (ISME, 2003).

Gambia

Land area [km²]	10 000
Coastline [km]	502.7
Population ['000]	1 517
Population density [per km²]	134
Annual population growth rate [%]	2.35
Number of mangrove species in country	7
Total mangrove area [km²]	581
% of African mangrove cover	2
Estimated change 1980–2006	Slight decline
Mangrove area falling within protected areas [%]	3.5

STATUS

Table of mangrove area estimates

Source Year	1980	1990	1997	2000	2005	2006
Area [km²]	704	612	747	581	580	581

Gambia is, in effect, an enclave within Senegal, formed along the valley of the navigable Gambia River (Spalding *et al.*, 1997). An almost continuous belt of mangroves exists from the mouth of the Gambia River to about 160 kilometres inland, representing the most pristine of the remaining natural habitats in the country (FAO, in press). The extent of the mangrove swamp tends to decrease in the lower parts of the river and is better developed at the mouths of small tributaries further upstream. Mangrove stands, reaching to over 20 metres in height, are found between 100 and 160 kilometres upstream from the sea, near Tendaba, Elephant Island and Dan Kun Ku Island where average salinity of the water during the dry season is about 10 parts per thousand. Along the flat topography of the Gambia River valley, several mangrove formations exist, from the estuarine formations found near the capital Banjul to the tall fluvial formations found in the upstream extremes of their range (FAO, in press).

The Ramsar Convention came into force for Gambia on 16 January 1997. Presently the country has one Ramsar site with mangrove stands: Bao Bolong Wetland Reserve, designated 16 September 1996, North Bank Division and covers an area of 200 square kilometres (13°50'N 015°90'W) (Ramsar, 2000). There are also several coastal and marine habitats of ecological importance including: Toll Point to Cape Creek (Camaloo Corner), Oyster Creek mangrove swamp, Tanji Bird Reserve, Tujereng lagoons, River Kakima Delta-kachuma forest, Dau Dula to Kartong coastal forest and Kartong Point at the mouth of the Allahein River (Department of Parks and Wildlife Management, 1998).

BIODIVERSITY

Seven of the eight species of mangrove to be found in West Africa are present in Gambia:

Acrostichum aureum
Avicennia germinans
Conocarpus erectus
Laguncularia racemosa
Rhizophora mangle
Rhizophora harrisonii
Rhizophora racemosa

Watercourses that are affected by the daily tides are bordered by tall *Rhizophora racemosa*. Areas affected by the mean limits of the spring tides are populated by *Avicennia germinans* (syn *A. Africana*) and *Laguncularia racemosa*. *Rhizophora harrisonii*. *Rhizophora mangle* occur at the boundary between the *R. racemosa* and *A. germinans* stands. *Rhizophora racemosa* appears to be the pioneer species and is later replaced by *A. germinans* until the raised soils become too dry to support vegetation during the dry season. *Rhizophora* spp. can reach heights of up to 20 metres (FAO, in press).

THREATS AND DRIVERS OF CHANGE

Key drivers of change in Gambia: Climate change; habitat changes upstream.

Mangroves in Gambia suffered a slight decrease in extent due to diebacks; most likely caused by drought, increase in soil salinity, illegal exploitation and conversion of tidal areas into shrimp and fish farms. The drought that affected Africa in the 1970s caused the deterioration of many mangroves, especially along the Bintang Bolon, the largest tributary of the Gambia River. It led to deeper tidal penetration and increased water and soil salinity, the main causes of the dieback. An important threat to mangroves in the Banjul area is the oyster harvest, which cuts the branches and roots where oysters anchor. The construction of access roads allows people to easily access the inner parts of the forests, applying further pressures on the ecosystem (FAO, in press). In the coastal areas, sand mining for construction is another indirect cause of mangrove degradation (Said, 2007).

Bao Balong Wetland Reserve is threatened by non-urbanized settlements, commercial fishing, grazing, rice growing, overgrazing by livestock, persistent droughts and salination of the soil (Ramsar, 2006b).

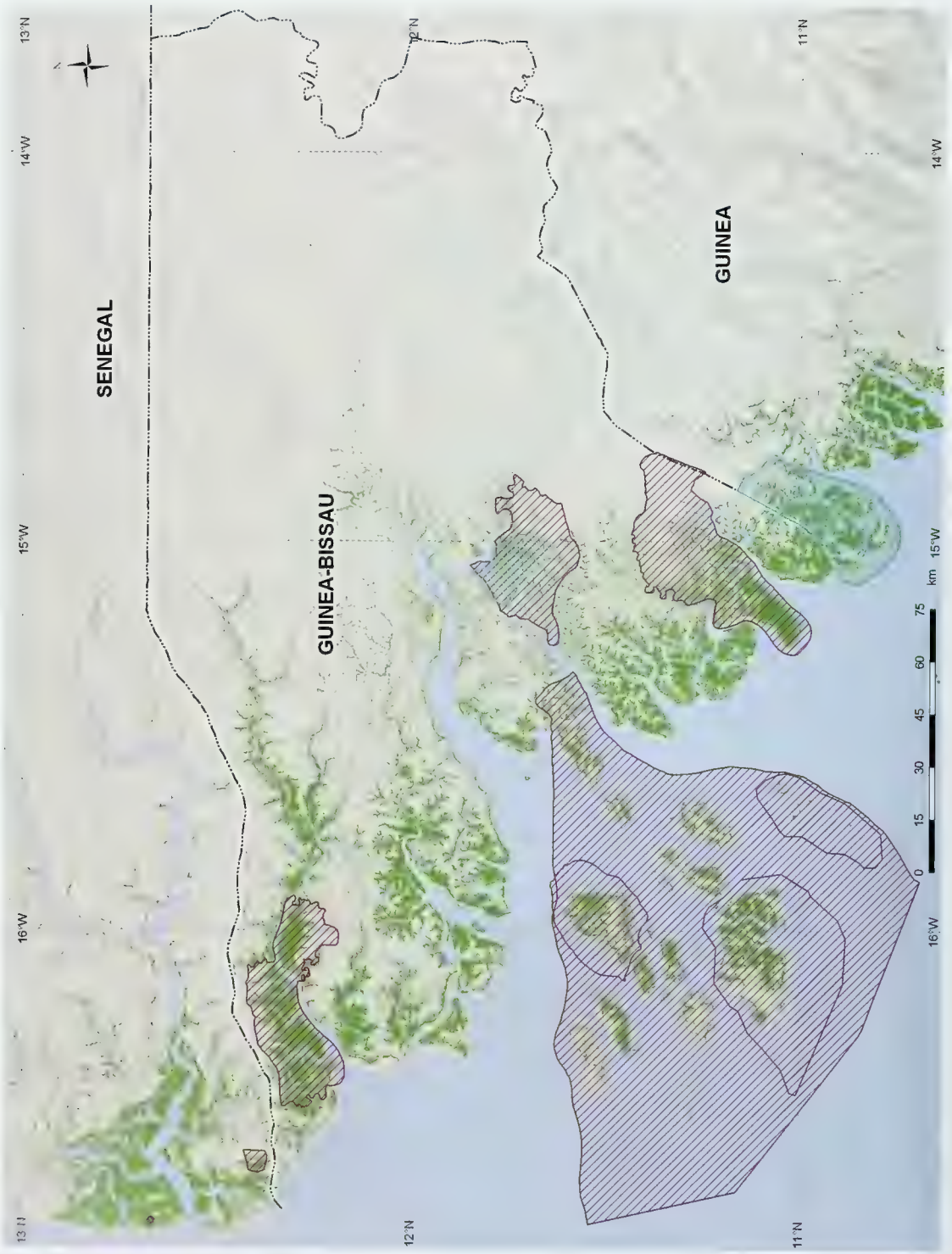
N
14°N
13°30'N
13°N
15°W
15°30'W
16°W
16°30'W
SENEGAL
THE GAMBIA
GUINEA-BISSAU
0
10
20
30
40
50
km

ECONOMIC ACTIVITY ASSOCIATED WITH MANGROVES

Mangrove wood is mainly used by villagers for fencing poles, posts, roofing material, firewood and fuelwood production. The fuelwood is either for local consumption or for sale in Banjul. Relevant non-timber forest products extracted from the mangroves in Gambia are honey, fodder and medicine. Heavy clearing has taken place on the North Bank and in the Lower River Division, where mangrove areas have been converted to rice swamps. Educational and scientific research activities as well as ecotourism are also on-going in these forests. The tall mangroves are an important sustainable source of forest products. These systems are highly productive and it might be possible to utilize and manage the *Rhizophora* stands of the lower Gambia River basin on a 30-year rotation (FAO, in press).

In the early 1980s, fishing was undertaken by mainly small, local fishing units, and foreign units accounted for only 15 per cent of the total. Twenty years later, estuarine fishing is predominately carried out by about 100 fishing companies involving 800 fishermen (more than 80 per cent of whom are foreigners) using more than 1750 stownets. Because of the globalization of fish markets, in 2002, Gambia exported 150 tonnes of shrimp to West Africa and 350 tonnes to Europe. Consequently, the fishery has become a quasi mono-exploitation of shrimp for export (Laë *et al.*, 2004). This change in fisheries practices is likely to have negative effects on mangroves in the area.

In Bao Balong Wetland Reserve, the area's aquatic vegetation (reeds, edible plants, mangrove products) is used by local people. They cut vegetation for small-scale/subsistence uses, collect non-timber forest products and grow rice (Ramsar 2006b).


SENEGAL
GUINEA-BISSAU
GUINEA
13°N
12°N
11°N
16°W
15°W
14°W
0
15
30
45
60
75
km

Guinea Bissau

Land area [km^2]	28 120
Coastline [km]	3 176.0
Population ['000]	1 586
Population density [per km^2]	44
Annual population growth rate [%]	2.92
Number of mangrove species in country	6
Total mangrove area [km^2]	2 999
% of African mangrove cover	Increase
Estimated change 1980–2006 [%]	8
Mangrove area falling within protected areas [%]	35.5

STATUS

Table of mangrove area estimates

Source Year	**1980**	**1990**	**1997**	**2000**	**2005**	**2006**
Area [km^2]	2 760	2 480	3 649	2 210	2 100	2 999

The topography of Guinea-Bissau is generally low coastal plain with forest covering over 70 per cent of the country (Mongabay, 2006). The most extensive mangrove forests are in the north of the country. The mainland coast is characterized by many estuaries with marshy forests of mangrove, and a tidal influence up to 150 kilometres inland. The Bijagós Archipelago of Guinea-Bissau (including the Bolama area) is composed of some 88 islands and islets and a large intertidal area of mudflats and mangroves. The archipelago is situated just off the coast, opposite the mouth of the Rio Gêba. The archipelago was designated as a biosphere reserve in 1996, and has three protected areas designated within its territory. The land area of the archipelago is some 1000 square kilometres, while a further 1000 square kilometres or so are uncovered twice daily by the retreating tide, of which at least 760 square kilometres are mudflats and 350 square kilometres are mangroves (African Birding Club, 2005).

Two of the three protected areas of the Bijagós Archipelago have significant mangrove areas. The Orango National Park has suffered approximately 10 per cent decrease between 1956 and 1998, but currently contains one third of the archipelago's mangroves. The Urok Park has approximately 66 square kilometres of mangroves (Said, 2007).

Parque Natural dos Tarrefes do Rio Cacheu includes some 300 kilometres of mangroves, some of the most extensive in the country.

Since 1980 the mangroves appear to have undergone a slight increase in extent and represent a particularly important resource in the country. (FAO, in press).

Guinea Bissau has one Ramsar site with mangroves: Lagoa de Cufada, which covers an area of 391 square kilometres and was designated in 1990 (11°43'N 015°02'W).

BIODIVERSITY

Six mangrove species are present in Guinea-Bissau:

Avicennia germinans
Conocarpus erectus
Laguncularia racemosa
Rhizophora harrisonii
Rhizophora mangle
Rhizophora racemosa

The mangroves are particularly well developed in the north and widespread species are *Rhizophora* spp., *Laguncularia racemosa* and *Conocarpus erectus*. They can grow up to 10 metres high and grow from 20 to 100 metres along the rivers. Guinea-Bissau mangroves tend to consist of low-growing stands, less than 5 metres in height and primarily consisting of *Rhizophora* sp. and *Avicennia* sp. Islands of mangroves may also be found dispersed on the saline plains ranging between the mangrove forests and neighbouring savannas (FAO, in press).

The mudflats of the Bijagós Archipelago are home to the rare mangrove species *Laguncularia racemosa* and in West Africa are second only in importance to the Banc d'Arguin in Mauritania for the numbers of Palearctic waders present during the northern winter (African Birding Club, 2005) when it is estimated up to 900 000 birds congregate and over 282 avian species have been recorded (Dodman *et al.*, 2004).

Other species noted in the archipelago include (Dodman *et al.* 2004):

- Five species of marine turtle (Green Turtle *Chelonia mydas;* Loggerhead Turtle *Caretta caretta;* Olive Ridley Turtle *Lepidochelys olivacea;* Hawksbill Turtle *Eretmochelys imbricata* and Leatherback Turtle *Dermochelys coriacea);*
- West African Manatee *Trichechus senegalensis;*
- Hippopotamus *Hippopotamus amphibious;*
- (West) African Dwarf Crocodile *Osteolaemus tetrapsis* and
- The Atlantic Hump-backed Dolphin *Sousa teuszii.* and the Great Dolphin *Tursiops truncates.*

Parque Natural dos Tarrefes do Rio Cacheu provides important breeding areas for fish, crustaceans and molluscs and also provides refuge for a large number of birds, many migratory. At least 180 bird species have been recorded there (Dodman *et al.*, 2004) and 40 terrestrial mammals (Said, 2007). West African Manatee *Trichechus senegalensis* occurs in the Cacheu River and its tributaries (African Birding Club, 2005).

THREATS AND DRIVERS OF CHANGE

Key drivers of change in Guinea-Bissau: destruction of habitat as a result of population increase.

Subsistence activities: Nearly 60 per cent of the country's population lives in the coastal zone. Mangroves have decreased due to their conversion into rice plantations. Traditional rice growing on saline ground uses seawater, which penetrates the rice plantations during the dry season to reduce the acidity of the soil. The fish and shellfish, which live in this ecosystem, represent the principal source of protein for local communities (FAO, in press). Charcoal production, fires, fuelwood cutting and logging have resulted in forest loss and subjected Guinea-Bissau to serious soil degradation and erosion in some areas (Mongabay, 2006).

Urban and industrial development: Coastal mangrove swamps are being destroyed due to hydroelectric projects and dam construction (Mongabay, 2006).

Threats within and around Guinea Bissau's Ramsar site include: urban and agricultural development, overfishing and excessive hunting (Ramsar, 2006b).

ECONOMIC ACTIVITY ASSOCIATED WITH MANGROVES

Mangroves are exploited as a key resource by communities living along the coast for fuelwood, processing of fish, salt production, drinks and construction materials as well as supporting fishing, gleaning, agriculture, rice production and the production of medicinal products (FAO, in press). Specifically, coastal communities gather leaves, buds and firewood, as well as taking timber and mud, fish, molluscs and crustaceans. They harvest honey and salt in mangrove areas. Groups have traditionally grown flooded rice in mangroves, areas termed "bolanhas de tarrafe". When the rice harvest is not sufficient, communities have been known to grow other cereal crops such as maize, millet and sorghum, especially in farming areas in contact with Islamic groups (IUCN, 1994).

RECENT EVENTS

There are increasing problems with the saltwater intrusion of rice-paddy irrigation channels caused by flooding from mangrove forests in addition to low rain, pests and crop diseases that have blighted around 70 per cent of cultivable land in some areas of Guinea Bissau resulting in widespread food insecurity (OCHA, 2006). This may become more widespread as lands that are more marginal are used for crop cultivation.

Despite the identified threats to mangroves, some regeneration is being observed in the country (Said, 2007).

The Republic of Guinea

Land area [km²]	245 720
Coastline [km]	1 614.5
Population ['000]	9 402
Population density [per km²]	38
Annual population growth rate [%]	2.18
Number of mangrove species in country	7
Total mangrove area [km²]	2 039
% of African mangrove cover	7
Estimated change 1980–2006	Moderate decline
Mangrove area falling within protected areas [%]	0.2

STATUS

Table of mangrove area estimates

Source Year	**1980**	**1990**	**1997**	**2000**	**2005**	**2006**
Area [km²]	2 992	2 792	3 083	2 762	2 760	2 039

The continental shelf of Guinea extends 300 kilometres along the coast and covers an area of 47 400 square kilometres, making it the largest in West Africa (Government of the Republic of Guinea, 2002). The littoral zone is characterized by a sandy coast, vast plains with abundant vegetation and mangrove forests providing habitat for a large number of marine species (Government of the Republic of Guinea, 2002).

Mangroves are found along the length of the Guinean coast except for Cape Verga and Kaloum Island. The topography of the coastal area facilitates the deposition of sediment and submersion of the mouths of the rivers. There is a long tidal reach up the estuaries, which causes flooding of the rivers, leaving raised bars. It is here that the mangroves can develop, within the bay of the estuary. Mangroves extend more than 10 kilometres inland and, for the widest rivers, they can be found up to 40 kilometres inland from the coast (FAO, in press).

Guinea has four Ramsar sites that contain mangroves designated in 1992. These are:

Iles Tristao. Covering 850 square kilometres (10°55'N 015°00'W);

Rio Kapatchez. Covering 200 square kilometres (10°25'N 014°33'W);

Rio Pongo. Covering 300 square kilometres (10°08'N 014°08'W);

Konkouré. Covering 900 square kilometres (09°45'N 013°41'W).

BIODIVERSITY

Seven species of mangrove have been identified in Guinea:

Acrostichum aureum
Avicennia germinans
Conocarpus erectus
Laguncularia racemosa
Rhizophora harrisonii
Rhizophora mangle
Rhizophora racemosa

Species distribution of woody mangroves varies by site. *Avicennia* spp., needs greater substrate stability and is generally found in the shallows along the channels going inland, whereas *Rhizophora* spp., *Avicennia* spp. and *Laguncularia* spp. prefer convex banks prone to high sedimentation. According to Yansané (1998), non-woody mangroves of Guinea tend to be located in degraded areas.

In denuded areas, *Avicennia* spp. and *Rhizophora* spp. are found in mixed settlements along banks of the channels. More developed "forest cathedrals" are found along the Konkouré River where there is fresh water from inland. *Avicennia germinans* and grassy species often colonize the deforested areas intended for rice growing. *Rhizophora racemosa* can reach 25 metres in height in Kakounsou and in the Bay of Sangaréya, but in other areas, the trees seldom exceed 8 metres and are often much smaller. In the same zone, *Avicennia germinans* grows up to 15 metres and *Conocarpus erectus* can also be found here (FAO, in press).

The biological diversity on the coastal shelf of Guinea depends on the input of organic matter and detritus from the coastal mangroves (Shalovenkov, 2000). It has also been noted that a great number of seabirds use the mangrove forests for feeding, reproduction and shelter (Sagno, 2005).

THREATS AND DRIVERS OF CHANGE

Key drivers of change in Guinea: Rapid population growth in the coastal zone.

The harvesting of wood from mangrove forests is a major source of energy. Household consumption of firewood and charcoal totalled 4 713 040 tonnes in 1998, while the informal sector consumed nearly 180 700 tonnes in 1996 (Samoura and Diallo, 2003). It is clear that natural resources are being degraded, threatening not only timber products, but also all the goods and services provided by mangrove forests (Government of the Republic of Guinea, 2002).

15°W
14°W
13°W
GUINEA-
BISSAU
11°N
11°N
GUINEA
10°N
10°N
9°N
9°N
SIERRA
LEONE
15°W
14°W
0 10 20 30 40 50
km
13°W

Expansion of the port of Kamsar in the bay of Sangaréya has resulted in the loss of 700 000 square metres of mangroves; although reforestation of the same area using *Rhizophora* sp. and *Avicennia* spp. was undertaken between 1993 and 1998 to help mitigate these effects (FAO, in press).

Other threats include (FAO, in press; Samoura and Diallo, 2003):

- Clearing of mangrove for wood to smoke fish
- Clearing of mangrove for salt extraction
- Habitat modification for rice culture and shrimp culture
- Overexploitation of oyster and crab populations
- Ramsar (2006b) highlight poaching, clearing of vegetation, commercial-scale forest exploitation and industrial-waste pollution as threats that occur within Ramsar sites.

ECONOMIC ACTIVITY ASSOCIATED WITH MANGROVES

Rice culture: 13 per cent of the national rice production in Guinea is from mangrove areas and provides livelihoods for over 50 000 rice farmers. Shifting agriculture also occurs where salt inundation is low.

Fish breeding: fishing and gleaning of shell fish.

Wood harvest: for fish processing (smoking), fuel, construction and charcoal production for both rural and coastal cities.

Salt production: a seasonal activity, post harvest, undertaken predominately by women. It requires large quantities of wood. Salt is produced by a local method through the evaporation of brine derived from washing salt rich mangrove mud

Bauxite processing: Guinea possesses between 25 and 30 per cent of the world's reserves of bauxite. The three mines produce 80 per cent of the countries export revenue Processing and transport takes place in the coastal zone, however no literature has been found to demonstrate the impact on Guinea's mangroves (International Development Research Centre, 1990; FAO, in press).

Emily Corcoran

13°W
12°W
GUINEA
9°N
9°N
SIERRA
LEONE
8°N
8°N
7°N
7°N
LIBERIA
0 10 20 30 40 50
km
13°W
12°W

Sierra Leone

Land area [km²]	71 620
Coastline [km]	1 677.1
Population ['000]	5 525
Population density [per km²]	77
Annual population growth rate [%]	2.09
Number of mangrove species in country	6
Total mangrove area [km²]	1052
% of African mangrove cover	3.5
Estimated change 1980–2006	Moderate decline
Mangrove area falling within protected areas [%]	14.5

STATUS

Table of mangrove area estimates

Source Year	**1980**	**1990**	**1997**	**2000**	**2005**	**2006**
Area [km²]	1 677	1 454	1 695	1 053	1 000	1 052

Mangrove forests are found along the length of the coastal area, usually on tidal flats at the mouths of rivers with concentrations in the four main estuaries, Scarcies, Rokel, Yawri Bay and Sherbro Rivers (Government of Sierra Leone, 2003). Stilted shrubs or trees are frequent and mangroves may reach up to 35 metres in height. Along creeks, the trees are larger and the forest is dense. The mudflats between creeks have a low mangrove cover and are usually less dense. The most extensive stands are located in the northern part of the country (FAO, in press).

The Sierra Leone River Estuary was designated as a Ramsar site on 13 December 1999 and covers an area of 2950 square kilometres (08°37'N 013°03'W).

BIODIVERSITY

Six mangrove species occur in Sierra Leone:

Avicennia germinans
Conocarpus erectus
Laguncularia racemosa
Rhizophora mangle
Rhizophora harrisonii
Rhizophora racemosa

The main tree species are *Rhizophora racemosa, R. mangle* and *R. harrisonii*. The first is a pioneer species at the edge of the water; the other two are dominant upstream at the tidal limits, where *Avicennia germinans* (syn *A. nitida*), *Conocarpus erectus* and *Laguncularia racemosa* are also found. On the fringe of the mangroves, grasses occur together with ferns and halophytes. Mangroves extend far up the rivers to the extent of the tides. *Rhizophora racemosa* is commonly found in association with *Avicennia* on the mudflats, but *R. racemosa* grows exclusively in areas of well-consolidated soil and there is an input of freshwater, sometimes reaching a height of 35 metres (FAO, in press).

The Sierra Leone River Estuary is one of four major coastal estuarine wetland sites identified as important for Palearctic migrant waders in Sierra Leone and the site is dominated by mangrove vegetation. The site supports at least eight wintering waterbirds species whose numbers here exceed one per cent of their global population. These are: *Charadrius hiaticula; Pluvialis squatarola; Calidris alba; C. ferruginea; Numenius phaeopus; Tringa nebularia; T. totanus* and *Egretta gularis*. The estuary reserve receives 20 000 waterbirds on a regular basis and in 1995, 36 waterbird species were recorded. The mangrove forests provide breeding habitat for some of these waterbirds. The site includes 19 per cent of Sierra Leone's total mangrove swamp. (Ramsar, 2006a; BirdLife International, 2005).

THREATS AND DRIVERS OF CHANGE

Key drivers of change in Sierra Leone: Political instability; land-use and resource-use changes resulting from population growth; land-based sources of pollution.

The mangrove forests in Sierra Leone have been heavily exploited due to rapid population increase and high levels of poverty. The high demand for the land and wood coupled with the lack of community participation in the management of mangrove resources has created a *de facto* open-access regime (Government of Sierra Leone, 2003). This has resulted in mangrove cover that consists mainly of low regrowth with few larger trees, especially in the area around Freetown. Important threats are also posed by siltation and pollution of estuaries (FAO, in press).

Dumping of untreated waste from industries in the Freetown area and oil spillage from tankers unloading at the main port threaten the wildlife in the Sierra Leone Estuary (BirdLife International, 2005). Even inside reserves, vegetation clearance and unsustainable fishing activities threaten the mangrove ecosystem (Ramsar, 2006a). This was especially the case during the civil war in the 1990s; regional forestry officers, foresters, rangers and guards went unpaid for long periods, while logging and massive

deforestation occurred in forest reserves (WRI, 2003a).

ECONOMIC ACTIVITY ASSOCIATED WITH MANGROVES

Key economic activities taking place include:

- Harvesting of wood for construction, fuel, fish-processing, salt production
- Clearing of mangroves for salt production and rice culture
- Fishing industry
- Agroforestry

Protection and economic activity co-exist in some areas. Traditional fishing and agro-forestry can be sustainably managed in collaboration with an existing EU-funded Artisanal Fishing Community Development Programme in the Sierra Leone River Estuary wetland (FAO, in press).

RECENT EVENTS

Sierra Leone is a country with substantial mineral and fishery resources. It emerged from a decade of civil war in 2002 (Government of Sierra Leone, 2003).

Liberia

Land area [km²]	96 320
Coastline [km]	842.0
Population ['000]	3 283
Population density [per km²]	29
Annual population growth rate [%]	2.92
Number of mangrove species in country	6
Total mangrove area [km²]	110
% of African mangrove cover	0.5
Estimated change 1980–2006	Moderate decline
Mangrove area falling within protected areas [%]	26.1

STATUS

Table of Mangrove area estimates

Source Year	1980	1990	1997	2000	2005	2006
Area [km²]	193	143	427	92.5	67.5	110

Thirteen and a half per cent of the nation's total area is covered with water extending along the total length of the coastline (Government of Liberia, 2004) and Gatter (1988) estimated that in 1998, mangroves covered 0.5 per cent of the land surface of Liberia, equivalent to a 500-kilometre-wide belt. Except for few places in the central part of the country, primary mangrove forest has been replaced by secondary mangrove forest. These mangroves characterize the wetlands of Liberia and cover a small area along the coast, from Cape Mesurado to Cape Palmas, at the edges of lagoons, swamps and along the banks and estuaries of six rivers (Government of Liberia, 2004; FAO, in press).

The Ramsar Site of Lake Piso, a very large open lagoon near the border with Sierra Leone, supports an important series of mangrove swamps (FAO, in press). Designated on the 7 February 2003 the site covers an area of 760.91 square kilometres (06°45'N 011°13'W).

BIODIVERSITY

Six true mangrove species are found in Liberia:

Acrostichum aureum
Avicennia germinans
Conocarpus erectus
Rhizophora mangle
Rhizophora harrisonii
Rhizophora racemosa

The most common species is *Rhizophora racemosa*. The lagoon mangrove communities around Cape Palmas in south-eastern Liberia attain a height of 3 metres and are dominated by *Conocarpus erectus* with only rare specimens of *Avicennia germinans* and *Rhizophora racemosa*. Thickets of *Acrostichum aureum* are also common. On the central Liberian coast estuarine mangroves consist of *Rhizophora harrisonii*, *Avicennia germinans* and *Conocarpus erectus*. Here, *Rhizophora* spp. and *Avicennia germinans*, most likely due to poor soil conditions, rarely grow taller than 6 metres. They are always taller when closer to river channels than in areas inundated with saline water, where usual growth is 2–2.5 metres in height (FAO, in press). Mature mangroves that reach heights up to 30 metres have been found along the lower Sehnkwehn and some neighbouring rivers, where species such as *Rhizophora harrisonii*, *Rhizophora mangle* and *Avicennia africana* occur together with impressive tracts of *Pandanus* (Government of Liberia, 2004).

Mangrove forests of Liberia serve as spawning grounds for many fish species, crabs, shrimps and molluscs, as well as providing habitats for many endangered species of manatees, crocodiles, turtles and migratory birds (Government of Liberia, 2004).

THREATS AND DRIVERS OF CHANGE

Key drivers of change in Liberia: Political instability, population increase and urban development.

One of the major drivers of change to mangroves of recent times has been civil unrest and the resultant displacement of communities to the coast. Since a military coup in 1980, Liberia has experienced a period of intense political, economic and social disruption. The Civil War of 1990 began in the rural parts of Liberia. Hostilities resumed in 2001, culminating in violence throughout the country in 2003 (Ramsar/EPA, 2006). This widespread unrest forced rural inhabitants towards the major cities along the coast, with the population of Monrovia increasing from 250 000 to over a million (Ramsar/EPA, 2006). The capital was not able to hold all the displaced people and so many remained in the surrounding mangrove and wetland areas.

The mangrove forests became the primary target for livelihoods, providing construction materials for shelter, food, fuelwood and water for irrigating crops. These basic goods and services were overexploited due to the high population density and resulted in the loss of large

SIERRA LEONE
GUINEA
LIBERIA
CÔTE D'IVOIRE
10°30'W
9°W
7 30'W
6°N
6 N
4 30'N
4 30'N
0 15 30 45 60 75 km

portions of the Mesurado and Marshall mangrove wetlands, and degradation of further areas as they became major dumpsites for city waste disposal (Ramsar/EPA, 2006).

Other threats include road-building, use of mangrove areas for landfills and urban expansion. A great deal of the damage has been along the edges of creeks around the larger towns and cities such as Monrovia, Buchanan, Greenville and Harper. *Rhizophora racemosa* appears to have disappeared from some of these areas due to the extensive felling (FAO, in press).

The Ramsar Site Information Service lists war as a threat to the mangroves of Lake Piso; most likely, due to the destabilizing effects it has on management efforts. Mining exploitation and exploration also continue to pose threats to the reserve (Ramsar, 2006b).

ECONOMIC ACTIVITY ASSOCIATED WITH MANGROVES

Mangroves are valued economically because of their utility as fish nurseries and ability to support traditional fisheries. In particular, the mangrove systems around Monrovia are important breeding grounds for various commercially viable aquatic species (fish, crabs, shrimps, water snail) (Wiles, 2005; Government of Liberia, 2004). The fishery sub-sector provides about 65 per cent of the protein needs of the country and contributes about 10 per cent to the GDP (Government of Liberia, 2004).

Local communities depend on mangrove wetlands for subsistence and local commerce, using wood to provide energy supplies, food, shelter, water, medicine, raffia palm for weaving and other ecological services. In locations where there is no electricity, mangrove wood provides fuel for preserving food and cooking (Ramsar/EPA, 2006).

The economic pressures and limited employment opportunities during and after the war have compelled many families to grow rice for the first time in order to survive. This drove cultivation of land that had never previously been considered for rice production, such as the coastal mangrove swamps. As a result, there are many more families in rice production than in pre-war times, albeit with smaller plots (FAO, 2000).

RECENT EVENTS

Liberia has recently developed its transition plan, which stresses the sustainable use of mangroves for fisheries resources (UN/World Bank, 2004).

GHANA
CÔTE D'IVOIRE
LIBERIA
6°N
4°30'N
3°W
4°30'W
6°W
7°30'W
0
20
40
60
80
100
km

Côte d'Ivoire

Land area [km²]	318 000
Coastline [km]	797.3
Population ['000]	18 154
Population density [per km²]	56
Annual population growth rate [%]	1.71
Number of mangrove species in country	5
Total mangrove area [km²]	99
% of African mangrove cover	0.3
Estimated change 1980–2006	Severe decline
Mangrove area falling within protected areas [%]	26.9

STATUS

Table of mangrove area estimates

Source Year	1980	1990	1997	2000	2005	2006
Area [km²]	302	201	644	99.4	99	99

Mangroves of the Côte d'Ivoire occupy a very restricted zone within the characteristically constant coastal climate (FAO, in press). There are two principal groups of mangroves:

(i) from Assinie to Fresco, characterized by rivers flowing into wide lagoons; and

(ii) between Fresco and the border with Liberia, along the Cavally River, consisting of a deltaic river system. The mangroves of the lagoons tend to be smaller, although in the Grand Bassam region they have been found to reach up to 20 metres high (FAO, in press).

Since the Côte d'Ivoire ratified the Ramsar Convention, it has designated six sites, with a total surface area of 1 273.44 square kilometres, of which four contain mangroves:

Complexe Sassandra – Dagbego. Designated 18 October 2005, Bas-Sassandra, with an area of 105.51 square kilometres (004°58'N 006°02'W);

Grand Bassam. Designated 18 October 2005, Sud-Comoé, with an area of 402.10 square kilometres (05°21'N 003°46'W);

N'Ganda N'Ganda. Designated 18 October 2005, Sud-Comoé, with an area of 144.02 square kilometres (05°10'N 003°24'W);

Parc national d'Azagny. Designated 27 February 1996, Lagunes, with an area of 194.00 square kilometres (05°12'N 004°53'W).

BIODIVERSITY

The mangroves of Côte d'Ivoire are represented by five true mangrove species:

Acrostichum aureum
Avicennia germinans
Conocarpus erectus
Laguncularia racemosa
Rhizophora racemosa

The lagoons are dominated by *Rhizophora racemosa*, *Avicennia germinans* and *Conocarpus erectus*, while the river system is dominated by *A. germinans* and *R. racemosa*. *R. racemosa* is more dominant on the outer edges of the lagoon followed by *A. germinans*, with *C. erectus* existing more towards the inside of the lagoon.

The Sassandra–Dagbego Complex on the Sassandra River estuary is one of the country's biggest rivers and is home to three mangrove species: *Rhizophora racemosa* (red mangrove), *Avicennia germinans* (black mangrove), and *Conocarpus erectus* (buttonwood mangrove) and forms the best-preserved mangrove stands in the country (Ramsar, 2006b). Primates, reptiles, tortoises, sea turtles, bats and more than 208 species of birds, especially waterfowl, including herons and gulls, are found here (Ramsar, 2006b). The mangroves at Grand Bassam are an important habitat of the chimpanzee, the lesser white-nosed monkey and the sooty mangabey, as well as a spawning and nursery site for molluscs, fish and crustaceans (Ramsar, 2006b).

THREATS AND DRIVERS OF CHANGE

Key drivers of change in Côte d'Ivoire: Population growth and urban development (pollution and clearing of mangroves); and recent increase in political instability.

Several causes have been identified as having direct pressure on mangroves resulting in their reduced extent in Côte d'Ivoire. These include (GEF, 2002; FAO, in press):
Clearing of mangroves – for urban development and the construction of dams and reservoirs.

Industrial and domestic pollution – in the urban areas of the Ebrié Lagoon mangroves have disappeared as a result of industrial and domestic pollution from the city of Abidjan,home to 3.5 million inhabitants and 60 per cent of the country's industry (GEF, 2002), and its subsequent eutrophication (Dufour and Slepoukha, 1975; Arfi *et al.*, 1981).

Unsustainable harvesting practices – the unregulated use of mangroves for traditional uses, such as: fuelwood, poles for construction and local sales are a threat to mangroves in the country. In the Grand-Lahou area, there is noticeable reduction in mangroves from overharvesting, though no data is available due to lack of monitoring. Clearing of mangrove habitat can result in loss of productivity and a decline in recruitment for fisheries; unregulated commercial exploitation of timber.

Destructive fisheries – practices using toxic chemicals have affected the mangrove forest, especially in the area of Grand-Lahou.

Mining of sand and other construction material in the coastal zone is a common practice and tends to destroy natural habitats such as mangroves.

ECONOMIC ACTIVITY ASSOCIATED WITH MANGROVES

Activities include the harvesting of timber for construction, fishing gear, fuelwood and fisheries. In addition, *coastal aquaculture* is practised at a subsistence level in the Ebrié and Grand-Lahou Lagoons and accounts for an annual production of 20 000 tonnes of fish. No mariculture activity occurs in the area (GEF, 2002).

Rice cultivation, although growing is limited to one season per year and such activities are limited by a number of constraints such as silting caused by tidal movement, risk of saltwater intrusion; pests such as crabs, high stress results in high disease incidence in crops (FAO, n.d.).

In addition, there are active fishing and cargo ports. The Vridi Canal was opened in 1950 and the port of Abidjan followed, with a significant impact on the economic activities of the country. Traditional fishing rapidly gave way to trawling and tuna fisheries. Substantial investments were further made with the construction of ice factories, canneries, cold-storage and fishmeal industries. Today, Abidjan has the largest tuna and container ports of West Africa. The port facilitated the huge development of industries with more than 60 per cent of the industries of the country located in the coastal zone or near Abidjan (tourism, oil refinery and offshore oil and gas exploration and exploitation). The port of Abidjan contributes to 96 per cent and 66 per cent of the country's import and export respectively, 90 per cent of the country's maritime traffic and 75 per cent and 40 per cent of the maritime trade of neighbouring landlocked countries of Burkina Faso and Mali respectively.

RECENT EVENTS

The attempted coup d'état of September 2002 has left the country divided (Simpson, 2003). The political and social ramifications of this event may exert their effect on the country's management of mangrove resources.

Ghana

Land area [km²]	227 540
Coastline [km]	757.8
Population ['000]	22 113
Population density [per km²]	93
Annual population growth rate [%]	1.9
Number of mangrove species in country	6
Total mangrove area [km²]	137
% of African mangrove cover	0.5
Estimated change 1980–2006	Moderate decline
Mangrove area falling within protected areas [%]	1.5

STATUS

Table of mangrove area estimates

Source Year	1980	1990	1997	2000	2005	2006
Area [km²]	181	168	214	138	124	137

In Ghana, mangrove swamps are very restricted in area and distribution and rarely develop beyond the thicket stage (FAO, in press). The most developed mangroves are found in the west of the country along the low-lying coastal belt between Côte d'Ivoire and Cape Three Points, primarily associated with the extensive lagoons on the west coast of the country. These lagoons, which comprise approximately 10 per cent of the country's total surface area (Ramsar, 2006b), are enclosed for part of the year by sediments, when rainfall is lower and freshwater outflow is not sufficient to counteract the ocean swells (Sackey *et al.*, 1993).

A secondary region of mangrove growth can be found bordering the lower reaches and delta of the Volta River. In 1992, it was thought that Ghana has lost approximately 70 per cent of its mangroves (IIED, 1992, in Macintosh and Ashton, 2003).

Ghana ratified the Ramsar Convention on 22 June 1988 and presently have five designated sites, which include mangrove habitats:

Muni Lagoon. Designated on 14 August 1992, covering 86.7 square kilometres (5°22'N 000°40'W);

Densu delta. Designated on 14 August 1992, Greater Accra, covering 46.2 square kilometres (05°33'N 000°18'W);

Sakumo Lagoon. Designated on 14 August 1992, Greater Accra, covering 13.4 square kilometres (05°40'N 000°10'W);

Songor Lagoon. Designated on 14 August 1992, Greater Accra, covering 287.4 square kilometres (05°45'N 000°30'E),

Anlo-Keta lagoon complex. Designated on 14 August 1992, Volta, covering 1,277.8 square kilometres (05°55'N 000°50'E),

In addition to Ghana's international commitments, there is a strong traditional base for protection of wetlands through indigenous management systems. Most wetlands and their resources have been protected and regulated in the past through varied traditional practices, depending on the beliefs of the traditional community that claims ownership. These traditional practices involve customary laws or taboos, which determine rights to land and resource use. They include the enforcement of sanctions for violation by the responsible authority (Ramsar, 2006b).

BIODIVERSITY

Six species of true mangrove are found in Ghana:

Acrostichum aureum
Avicennia germinans
Conocarpus erectus
Laguncularia racemosa
Rhizophora harrisonii
Rhizophora racemosa

The open lagoons tend to be dominated by *Rhizophora racemosa*, while closed lagoons with an elevated salinity contain *Avicennia germinans, Conocarpus erectus, Laguncularia racemosa* and *Acrostichum aureum. Laguncularia racemosa* and *Rhizophora racemosa* are found on the seaward side of lagoons in saline conditions. *Avicennia germinans* (syn *A. nitida*) occurs on the landward side of the mangrove swamps (FAO, in press).

Ghana's mangroves are renowned for the associated biodiversity they support, in particular providing resting grounds and nesting grounds for thousands of visiting migratory birds (Macintosh and Ashton, 2003).

THREATS AND DRIVERS OF CHANGE

Key drivers of change in Ghana: population growth; land-use change and land-based sources of marine pollution.

Throughout the country threats include:
Population increases – leading to overexploitation and the

TOGO
GHANA
CÔTE D'IVOIRE
6 N
4°30'N
0°
1°30'W
3 W
0 10 20 30 40 50 km

unregulated use of mangroves and mangrove forest goods and services for fishponds, saltpans, sugarcane production, clearing for building, fuel, fish processing and construction. In most areas, mangroves are secondary forests with degraded habitat due to the intensive wood use. The bark of *Avicennia germinans* is used for tanning fishing nets, as well as firewood and fish processing (Armah, 2006).

Increases in populations – have also lead to the conversion of lands, which change drainage patterns, development of urban centres and industry, conflicting land use and pollution (Ramsar, 2001). Discharge of domestic and industrial waste from land, ships and aircraft also threatens mangrove sustainability. Losses of mangrove areas have also been caused by reclamation of lands for agriculture, urbanization and salt ponds. The conversion of mangrove wetlands for solar salt production and expansion of towns and villages are current major destructive threats in Ghana (Armah, 2006).

Engineering in the rivers and coasts – construction of dams, dykes and sea walls for the regulation of water supply deprives many of the country's downstream wetlands of their normal water regimes. The construction of the Akosombo Dam (1964) on the Volta has drastically reduced the water availability to downstream communities. Mangrove exploitation intensified due to the displacement of people and loss of traditional livelihood activities in the region (Ramsar, 2001; Macintosh and Ashton, 2003). With loss of livelihoods, traditional management of mangroves seems to be collapsing at the Volta delta, where cultivation and sale of mangroves are important to the economy of the riparian communities. In the early 1960s, areas cleared of mangrove were planted or allowed to go fallow, then harvested after 12 to 15 years. This allowed the plants to set seed and regenerate. In recent years, however, mangroves are harvested every five to eight years, jeopardizing the sustainability of the traditional management practice (Armah, 2006).

Threats of various sorts are also reported within designated protected areas, both directly in the site and indirectly via changes in the water catchments. On-site threats include permanent pastoral agriculture, commercial fishing, sand/gravel extraction and salt production. Negative impacts in the catchment zones include: sedimentation/siltation; erosion; overgrazing by domestic livestock; loss of natural vegetation through slash and burn agriculture; domestic sewage pollution; solid-waste pollution; poaching; industrial development; expansion of settlements; pesticide/herbicide pollution; dam impacts, which can alter the flow regime, and impacts from the extraction of rock, gravel and sand (Ramsar, n.d.).

There is currently no centralized body to deal with issues relating to the sustainable use of mangroves and responsibility is shared through a number of different government divisions and other organizations. There is currently no single comprehensive legislation to deal with use of natural resources (Macintosh and Ashton, 2003).

ECONOMIC ACTIVITY ASSOCIATED WITH MANGROVES

There is a strong traditional use of mangrove products and the mangrove environment including the exploitation of wood, fish, crabs and oysters. Other activities include production of salt, use of wood for fish processing, production of local gin, domestic firewood and construction (Macintosh and Ashton, 2003).

Ramsar sites with mangroves in Ghana serve a variety of purposes. These include scientific research, conservation education and bird watching, but also traditional/cultural uses, subsistence fishing and hunting such as the gathering of shellfish and non-consumptive recreation (Ramsar, n.d.).

RECENT EVENTS

The expansion of Accra city has led to the clearing of over half of the mangroves and significant areas of marshland (GIWA, 2006).

Avicennia germinans

C. Gordon

BENIN
TOGO
GHANA
1°12'0"E
1°24'0"E
1°36'0"E
1°48'0"E
6°24'0"N
6°12'0"N
N
0 2 4 6 8 10
km

Togo

Land area [km^2]	54 390
Coastline [km]	52.7
Population ['000]	6 145
Population density [per km^2]	108
Annual population growth rate [%]	2.54
Number of mangrove species in country	3
Total mangrove area [km^2]	11
% of African mangrove cover	<0.1
Estimated change 1980–2006	Increase
Mangrove area falling within protected areas [%]	0

STATUS

Table of mangrove area estimates

Source Year	**1980**	**1990**	**1997**	**2000**	**2005**	**2006**
Area [km^2]	10	10	No data	10	10	11

The coastal zone of Togo is characterized by lagoons that form in coastal depressions behind the sandy coastline, and are primarily colonized by mangrove vegetation (Johnson *et al.*, 2001). The mangroves of Togo are well preserved along the Mono River and its tributaries as well as along the Gbaga River and its tributaries. Isolated patches of mangrove are found at the mouth of the Aheno lagoon (FAO, in press), however, mangroves are threatened in some areas (Kodjo, 2006b). Mangrove trees tend to reach approximately 10 metres in height, although can reach a maximum of 20 metres (FAO, in press).

BIODIVERSITY

According to the FAO 2005 Thematic Study (in press), two of the eight mangrove species of West Africa are found in Togo, *Rhizophora racemosa, Avicennia germinans*. A recent national inventory, however, also identifies a third species of true mangroves, *Conocarpus erectus*, located in the villages of Séko and Agouégan (ANCE, 2005).

The inventory indicates that Togolese mangroves are composed of four characteristic, dominant species and also 13 species of associated species in three groupings: ligneous species, Lianas species and hydrophytes (Togolese National Strategy for Mangroves Conservation, 2005).

Five species of plant found within the mangrove forests of Togo are reported as threatened with extinction (Togolese National Strategy for Mangroves Conservation, 2005):

Avicennia germinans
Conocarpus erectus
Chrysobalanus icaco subspp. *icaco*
Ficus trichopoda
Rhizophora racemosa

THREATS AND DRIVERS OF CHANGE

Key drivers of change in Togo: These include population growth and political instability:

Population increase: between 1960 and 2000, the population of Togo grew fourfold. The maritime region is the most densely populated region in Togo (Johnson *et al.*, 2001), where 45 per cent of the population live in 10 per cent of the land area. Togo is classified as one of the Least Advanced Countries by the World Bank and International Monetary Fund. It is estimated that 72 per cent of the population are considered poor, and unemployment rates in the rural population are reported at 70 per cent, heavily represented by women (ANCE, 2005).

Mangrove deforestation: as a result of unregulated and unsustainable harvesting of timber products from the mangrove forests (Johnson *et al.*, 2001).

Impact of dams on sediment transport along the coast and from watersheds: the construction of the hydroelectric dam on the River Mono is, for example, having an impact on the regime of the river flood patterns, and sediment transportation, and the construction of the Akassombo Dam on the Volta has affected the supply of sediment to the coast of Togo and Benin causing erosion of the sandy coast line.

Phosphate mining is a major activity in the coastal zone, which could affect mangroves through pollution and deforestation for construction of infrastructure (Johnson *et al.*, 2001).

Pollution of the coastal zone by industrial and urban waste (hotel and domestic), litter, leaching of chemicals and fertilizers for agriculture, in particular persistent organic poilutants (Johnson *et al.*, 2001; Kodjo, 2006a).

ECONOMIC ACTIVITY ASSOCIATED WITH MANGROVES

Subsistence agriculture and commerce are the main economic activities in Togo (US Department of State, 2006a). Mangrove timber is used for commercial exploitation and

Case Study: National action for mangrove conservation in Togo
Ebeh Adayade Kodjo

More than 80 per cent of the total surfaces of mangroves in Togo have already disappeared. Togo's NGO's and governmental authorities have recognized the urgent need for concrete actions to ensure the sustainable management of mangroves. Togo has developed an integrated approach to halt this decline. Key components are:

1. Conducting an exhaustive inventory of mangroves still surviving, including delimitation of the wetland and mangrove zones to be preserved;
2. Promoting the restoration of the mangroves that have already degraded through a vast programme of reforestation;
3. *Ex-situ* conservation of endangered mangrove associated species such as the manatee;
4. Multi-sectoral and integrated sustainable utilization schemes, stressing income-generating activities such as oyster and production;
5. Developing ecotourism in mangrove areas;
6. Reinforcing regional and international cooperation for the management of mangrove resources between Togo and Benin in the Gbaga channel;
7. Promoting organic agriculture in mangrove zones to reduce pollution in mangrove systems.

(ANCE. 2005. Brief Resume of Activities Carried On Mangroves Conservation in Togo. National Consumer and Environment Alliance of Togo/Ministry of Security of Togo. www.ancetogo.globalink.org. Accessed 8 August 2006.)

subsistence, for firewood, carpentry, and fishing equipment.

RECENT EVENTS

The death of President Gnassingbe Eyadema in 2005 resulted in increased political instability within Togo. After an appointed takeover, his son and successor, Faure Gnassingbe was elected President in April 2005 with a legacy of a declining economy and long history of fluctuating political stability (US Department of State, 2006).

Benin

Land area [km²]	110 620
Coastline [km]	152.7
Population ['000]	8 439
Population density [per km²]	75
Annual population growth rate [%]	2.98
Number of mangrove species in country	6
Total mangrove area [km²]	66
% of African mangrove cover	0.2
Estimated change 1980-2006	Increase
Mangrove area falling within protected areas [%]	0

Emily Corcoran

STATUS

Table of mangrove area estimates

Source Year	1980	1990	1997	2000	2005	2006
Area [km²]	21	16.5	17	13.5	11.5	66

The littoral zone of Benin consists of 120 kilometres of straight sandy coast without developed estuaries or deltas. The climate is sub-equatorial with two dry seasons and two wet seasons. The population is predominantly in the south of the country with 64 per cent occurring in rural areas.

The mangroves of Benin tend to be limited to the edge of the extensive network of brackish coastal lagoons in the south of the country. Macintosh and Ashton (2003) consider the mangroves of Benin to be in an advanced state of degradation, despite some efforts for replanting and community awareness.

The strong presence of traditional culture and religion (70 per cent of the population are animists) and use of traditional management, taboos and sacred areas contribute to the management of the aquatic resources, including mangroves. FAO (in press) reported that the religious beliefs of many of the local populations that live in these areas often contribute to the conservation of the mangroves.

The government of Benin has designated two Ramsar Sites: the Low Valley of Couffo, Coastal lagoon, Aho Channel and Lake Ahémé, covering an area of 475 square kilometres (06°30'N 002°00'E), and the Low Valley of Ouémé, lagoon of Oporto-Novo and Lake Nokoué, covering an area of 916 square kilometres (06°39'N 002°32'E).

BIODIVERSITY

Six species of mangroves are found in Benin (FAO, in press):

Acrostichum aureum
Avicennia germinans,
Conocarpus erectus,
Laguncularia racemosa,
Rhizophora harrisonii, and
Rhizophora racemosa

Rhizophora mangroves are not significant, possibly due to the irregular hypo-saline content of the lagoons; *Laguncularia* and *Rhizophora harrisonii* are also rare. In certain places, although the majority of mangroves grow fairly low and shrubby, one still finds mangroves attaining heights of up to 22 metres (FAO, in press).

Adite (2002) identified 51 species of fish that are associated with the mangrove habitats in Benin from 26 families. Species diversity varied considerably between the least and most degraded sites. *Saritherodon melanotheron* (blackchin tilapia) was the dominant fish species accounting for approximately 47 per cent of the biomass.

THREATS AND DRIVERS OF CHANGE

Key drivers of change in Benin: population increase in the coastal zone; upstream changes in land use.

Construction of the hydroelectric dams on the Mono River changed the its downstream characteristics and affected the mangrove ecosystems of Benin and Togo (FAO, in press), in particular reducing the flood periods, affecting the fish composition to one dominated by marine/estuarine fish (80 per cent marine: 20 per cent freshwater species), and potentially the composition of mangrove species (Adite, 2002).

6 48'0"N
2 24'0"E
NIGERIA
6 24'0"N
N
BENIN
2°E
TOGO
6°24'0"N
6°48'0"N
0 3 6 9 12 15 km
6°N
2°E
2 24'0"E

Mangroves exploitation: as mangroves are the only forest trees growing in the coastal lagoons (Macintosh and Ashton, 2003), they are intensively exploited for extraction or cleared for:

- Salt processing;
- Firewood: *Rhizophora racemosa* and *Avicennia africana* are selectively cut as preferred sources of firewood (Adite, 2002);
- Construction of houses and boats;
- Construction of Acadja (traditional extensive aquaculture in the coastal lagoons, in which branches are used to enclose an area of lagoon, to attract and breed fish).

Degradation of the mangroves has resulted in increased sediment loading of the water and decreasing lagoon depth. These changes have consequences for the ecological composition and the sustainability of current economic exploitation of the remaining mangroves and the heavily exploited lagoon systems.

Increased urban, tourism and industrial development in the coastal zone have lead to an increase in habitat loss through development and increased stress on remaining habitats due to dumping of domestic waste and minor agricultural run off into the lagoons (Macintosh and Ashton, 2003).

Within designated Ramsar Sites containing mangroves, threats such as cutting of vegetation for small scale or subsistence use, subsistence fishing, commercial fishing, and even permanent arable agriculture have been documented (Ramsar 2006b).

ECONOMIC ACTIVITY ASSOCIATED WITH MANGROVES

The majority of economic activities in the mangrove areas are undertaken at subsistence scale and include:

- Fishing (a male-dominated activity): the mangroves of Benin have been described as a multi-species fishery, where more than 90 per cent of the 51 fishes species are commercially exploited (Adite, 2002); the following are the most abundant: *Sarotherodon melanotheron, Kribia nana, Gerres melanopterus* and *Ethamalosa fimbriata, Liza falcipinus, Mugil* sp. and *Chrysichthys nigrodigitatus;*
- Gleaning: oyster collection (usually carried out by women);
- Seagrasses (found between mangroves and the sea) are harvested for mat weaving (a female-dominated activity);
- Salt extraction: it has been established that for every one cubic metre of mangrove wood, 100 kg of salt can be produced (FAO, in press);
- The lagoons also provide critical market and transport routes within Benin and between neighbouring countries.

Despite heavy degradation of mangrove areas, remaining mangrove stands are exploited predominantly by the local communities, but also by companies dealing in mangrove wood products, particularly in the Azizahoué area (Macintosh and Ashton, 2003).

RECENT EVENTS

Attempts have been made to restore the mangroves of Benin, between 1998 and 1999. Two hundred thousand *Rhizophora racemosa* and *Acicennia africanna trees* were planted with a survival rate of 62 per cent after 12 months (Macintosh and Ashton, 2003). Later in 1999, a further 470 000 mangroves were planted, although the survival rates are not reported. Supporting activities included awareness-raising and information provision to local communities, which benefited from the success of these programmes.

In response to the lessons learned from the experience of Hurricane Katrina in New Orleans, the government of Benin is seeking US$ 60 million to erect concrete barriers and build levees along strategic parts of the coast to protect its economic capital of Cotonou from the invasion of the ocean. There is some concern as to the potential environmental complications, which may result from such a project to coastal ecosystems (Okanla, 2005).

BENIN
NIGERIA
CAMEROON
EQUATORIAL GUINEA
6 N
4 N
4°E
6°E
8°E
0 15 30 45 60 75 km

Nigeria

Land area [km^2]	910 770
Coastline [km]	3 121.9
Population ['000]	131 530
Population density [per km^2]	142
Annual population growth rate [%]	2.09
Number of mangrove species in country	8
Total mangrove area [km^2]	7 386
% of African mangrove cover	22
Estimated change 1980-2006	Moderate decline
Mangrove area falling within protected areas [%]	3.4

STATUS

Table of mangrove area estimates

Source Year	**1980**	**1990**	**1997**	**2000**	**2005**	**2006**
Area [km^2]	9 990	9 980	11 134	9 970	9 970	7 386

The mangrove forests of Nigeria are the largest in Africa and are the third largest in the world after India and Indonesia (Macintosh and Ashton, 2003). Area estimates do suggest however that mangrove cover is declining, and has reduced by 26 per cent since 1980, although some authors indicate the decline started with the oil boom of the early 1970s (Ohimain, 2006a).

Mangrove swamps in Nigeria stretch along the entire coast and are found in nine of the 36 states. The largest extent of mangroves is found in the Niger Delta between the region of the Benin River in the west and the Calabar, Rio del Rey estuary in the east. A maximum width of 30 to 40 kilometres of mangroves is found on the flanks of the Niger Delta, which is a highly dynamic system. The lagoons of Lagos and Lekki dominate the coastal systems in the west. Both lagoons are fringed by mangroves and backed by swamp forests. In the far east of the country there is a second major delta/estuary system associated with the Cross River, which has a considerable mangrove area extending in a belt of 7–8 kilometres on both sides of the estuary and up to 26 kilometres in the deltaic zone at the head of the estuary (FAO, in press).

BIODIVERSITY

All of the eight mangrove species found in West Africa are found in Nigeria:

Acrostichum aureum
Avicennia germinans
Conocarpus erectus
Laguncularia racemosa
Rhizophora mangle
Rhizophora harrisonii
Rhizophora racemosa
Nypa fruticans

In the lagoons and deltas, *Rhizophora racemosa* is the dominant species. It is the pioneer at the edge of the alluvial salt swamp; *R. harrisonii* dominate in the middle zone and *R. mangle* are most common on the inner edge, while *Avicennia germinans* is mostly restricted to relatively higher salinity zones, especially at the river mounts opening into the ocean and mangrove forests adjacent to coastal beach ridges bordering the Atlantic Ocean (Ohimain, 2006b). In the estuaries, the species composition may be different. Here, *Nypa fruticans,* an introduced species, becomes more abundant. Mangroves in Nigeria generally do not exceed 10–12 metres in height, but extreme specimens may reach more than 40 metres, in particular at the creek edges and other areas containing recently deposited alluvium (Ohimain, 2006b). *Conocarpus erectus* and other woody species that grow at the edge of the swamps may be associated with the main species, predominantly near the sea (FAO, in press).

It is estimated that over 60 per cent of fish caught between the Gulf of Guinea and Angola breed in the mangrove belt of the Niger Delta.

THREATS AND DRIVERS OF CHANGE

Key drivers of change in Nigeria: Population growth and economic development

While fragmentation itself does not greatly affect mangrove biodiversity, of greater concern is the total amount of mangrove area lost to urbanization, industrialization and agriculture, as well as impacts from timber and petroleum exploitation (Diop, 1993).

Petroleum and gas exploration and production: Exporting oil from coastal areas is an economically important activity in Nigeria, but there are significant associated environmental threats such as oil spill, gas flaring and installation of infrastructure (Isebor and Awosika, 1993; NDES, 1997). Oil and gas installations are spread throughout the central and western parts of the Niger Delta and there are four tanker ports at the delta face (FAO, in press). Over the last 30 years,

Case study: Invasive Alien Species *Nypa fruticans*

Nypa fruticans (nipa palm), a mangrove species native to Southeast Asia, was brought from Singapore to Nigeria in 1906. It was introduced along the coasts of Calabar and Oron in eastern Nigeria to control erosion. However, the nipa palm spread westwards to the State of Ondo, where it invaded extensive areas and displaced valuable indigenous mangrove species, such as Rhizophora and an important palm, Raphia. It also posed other serious ecological and socio-economic threats by invading fish nursery and feeding grounds. Contrary to the situation in Southeast Asia, nipa palm is not utilized by the local people of Nigeria. The Federal Ministry of Environment has developed an intervention, the "Nypa Palm Control Programme" to control the spread of this invasive species. Under this programme, the nipa palm is being removed and areas rehabilitated with native mangrove species. Local people are also being made aware of some of the uses of the nipa palm, which includes thatching material, sugar, vinegar and alcohol (ISME, 2003).

seismic lines have been placed in the Niger Delta mangrove forests (Ohimain, 2001). Other activities linked to oil exploration that affect mangrove habitats, for example, the development of oilfield infrastructure in the mangrove areas of the Niger Delta requires dredging and/or vegetation clearance and creation of canals to enable navigable accesses and sand filling. During dredging, the soil, sediment and vegetation along the right of way of the proposed site are removed and typically disposed over the bank and in most cases upon fringing mangroves and then abandoned. The abandonment of the resulting dredged material has had a number of effects, including smothering of fringing mangroves, alteration of the surface topography and hydrology, acidification and water contamination, which has resulted in damage to vegetation and killing of fish. Consequently, former mangrove areas have been converted to bare earth, grassland or freshwater forest after several years of natural weathering. The impacts of dredging on mangrove is far reaching because it affects almost all the various components of the ecosystems including the mangrove vegetation, benthic invertebrates, fisheries, plankton, wildlife, soil, sediment and water quality and ultimately the poor people who depend directly on the rich biodiversity of the mangrove ecosystem for survival (Ohimain, 2001; 2003; 2004; Ohimain *et al.*, 2002; 2005).

One key area of concern is the rehabilitation of abandoned spoils. The practice of dumping and abandoning sulphidic dredged spoils along canal banks triggers a series of environmental problems leading to extreme acidification, heavy metal pollution, and general habitat degradation, which prevent the re-colonization of the sites by native species. The resultant spoil dumps remain bare for several years and then become colonized by invasive species. Later still, they may become attractive to the local population as sites for houses, fishing camps and home gardens, which is regarded as a positive impact, even though it has led to the emergence of communities dangerously close to oil and gas infrastructure (Ohimain *et al.*, 2004).

Deforestation: Some mangrove loss has occurred as a result of coastal erosion and deforestation for commercial timber trade and subsistence-level use of wood products such as fuelwood, fish processing and construction timber.

Urban development: Disposal of municipal solid wastes into the waterways is threatening the peri-urban mangroves especially in major cities/towns like Lagos, Port Harcourt, Warri and Yenagoa. Non-biodegradable wastes, particularly plastic and nylons that are carried into the mangroves during high tides, are often stranded on the mangrove pneumatophores as the tide recedes (Ohimain, 2006b).
Other threats that are cited include:

- Lack of data and information, poor coordination by responsible government departments and poor collaboration between stakeholders (Macintosh and Ashton, 2003).
- The use of poison and dynamite for fishing, siltation, erosion, construction of embankments, and growing population pressure in the coastal zone (Isebor and Awosika, 1993).
- Encroachment of the introduced nipa palm *Nypa fruticans*.

ECONOMIC ACTIVITY ASSOCIATED WITH MANGROVES

Twenty per cent of the population and most of the country's economic activities exist in the coastal states of Nigeria. Macintosh and Aston (2003) consider mangrove resources to be underutilized but also poorly managed. Mangrove ecosystems support industrial and subsistence activities in Nigeria, and are critical for food security for many living in abject poverty in the coastal zone.

Key economically exploited resources in the mangrove regions include:
Petroleum: 90 per cent of foreign exchange earnings are from petroleum over the last 15 years (Macintosh and Ashton, 2003), and natural gas.
Sand and gravel: mined at rates of 60–100 tonnes per day from lagoons, estuaries and beaches.

Ayobami Salami

***Rhizophora racemosa*, Nigeria**

Fishing: an important activity in most mangrove areas (FAO, in press). The inhabitants of historical settlements in the Niger Delta depend on fish (up to 100 per cent of dietary protein) (Macintosh and Ashton, 2003).

Industrial shrimp farming: a growing industry in Nigeria. Sponsored by the International Finance Corporation (IFC), a branch of the World Bank, the Shell Petroleum Company of Nigeria Contractors will receive funds to develop this activity with the support of the Nigerian President (Carrere, 2002). However, it has also been reported that the soil characteristics of mangrove swamps are not suitable for aquaculture, because of high acidity (Macintosh and Ashton, 2003).

Wood: commercial exploitation of wood for poles, pulp and paper in 1988 was estimated at 10 to 750 million cubic metres (Macintosh and Ashton, 2003). At a subsistence level, mangrove wood is used for fish stakes, fish traps, boat building, boat paddles, yam stakes, fencing, carvings, building timber and fuel (Carrere, 2002).

Tourism: not currently well developed in Nigeria, however, there are places where mangrove areas are being reclaimed for development of tourist infrastructure (Macintosh and Ashton, 2003).

Other uses: these include clearance of mangroves for cash crops (palm oil, coconut), the use of mangrove peaty soil for the embankment of eroding shorelines/creek banks, and the use of periwinkle shells in place of stones/chippings for mixing concrete for production of concrete. Use of oyster shells for the production of native chalk and lime for the treatment of acidic mangrove soils for crop production (Ohimain, 2006a).

RECENT EVENTS

There is growing tension between the communities of the Niger Delta and the oil companies because of lack of equity of benefits received. This is exacerbated by the extreme levels of food insecurity and poverty in these communities (Ohimain, 2006b). When oil spills occur, local water sources can be contaminated, which can result in sickness and death among residents of nearby areas. Fisheries resources are reduced when habitat is degraded from oil coating the breathing roots of mangroves (MAP, 2000).

In their Poverty Reduction Strategy Paper, published in 2004, Nigeria have listed mangroves under "Conservation of unique habitats", detailing the importance of the ecosystem for livelihoods and a strategy to combat threats to it by monitoring industries, conducting impacting assessments and strengthening law enforcement (Nigerian National Planning Commission, 2004).

NIGERIA
9 E
10 E
5 N
5 N
CAMEROON
4 N
4 N
Bioko
(EQUATORIAL
GUINEA)
3 N
3 N
0 10 20 30 40 50
km
9 E
EQUATORIAL GUINEA

Cameroon

Land area [km²]	465 400
Coastline [km]	1 798.7
Population ['000]	16 322
Population density [per km²]	34
Annual population growth rate [%]	1.60
Number of mangrove species in country	6
Total mangrove area [km²]	1 957
% of African mangrove cover	6
Estimated change 1980–2006	Moderate decline
Mangrove area falling within protected areas [%]	7.1

STATUS

Table of mangrove area estimates

Source Year	1980	1990	1997	2000	2005	2006
Area [km²]	2 720	2 563	2 494	2 515	2 500	1 957

Mangroves are very significant in Cameroon and predominately found in three regions:

(i) The boarder with Nigeria in the "Cirque" (rivers Akwayafe, Ndian and Meme);

(ii) The Cameroon Estuary, at the mouths of the Bimbia, Mungo, Wouri, Dibamba and Sanga rivers;

(iii) Smaller stands at the openings of the Sanaga Nyong, Lokoundje and Ntem rivers.

The table of mangrove area estimates show a dramatic decline in mangroves since 1980. Cameroonian mangroves are beginning to be managed collaboratively, with intergovernmental organizations, non-governmental organizations and the local authorities, as in the case with awareness efforts of FAO and Cameroon Wildlife Conservation Society (FAO, 2006).

BIODIVERSITY

There are six species of mangrove growing in Cameroon. The dominant mangrove species is the red mangrove *Rhizophora racemosa,* which accounts for over 90 per cent of all mangroves, followed by *Avicennia germinans*. Stands of *Rhizophora racemosa* have been found to grow up to 40–60 metres on the coastal zone, and when found in the interior, it only grows 4–8 metres in height (FAO, in press). Other mangrove species are only poorly represented but include:

Conocarpus erectus
Languncularia racemosa
Rhizophora mangle
Rhizophora harrisonni.

Two key patterns of zonation of mangroves have been observed (Fomete Nembot and Tchanou, 1998):

(i) In the Region du Cirque, the succession of species from the sea to dry land is as follows: *Rhizophora racemosa – Avicennia germinans – Pandanus candelabrum – Acrosticum aureum – Pandanus candelabrum – Rhizophora racemosa*;

(ii) In the Cameroon Estuary, around Doala, the sequence is as follows: *Rhizophora racemosa – Rhizophora harrisonni – Rhizophora mangle – Avicennia germinans – Avicennia* associated with *Laguncularia.*

These mangrove forests are generally poor in plant species, but contain a wide spectrum of fauna including insects, crabs, molluscs, amphibians, reptiles and large mammal species such as monkeys, the West African manatee (*Trichechus senegalensis*) and Atlantic humpbacked dolphins (Ajonina, 2006). Other important wildlife species found in the region include dwarf crocodile and slender-snorted crocodile and freshwater turtles. The extensive beaches are notable nesting grounds of five species of marine turtles. Mangroves serve as a nursery grounds to marine organisms, water birds and migratory birds. Recent surveys of the coastal wetlands by the Cameroon Wildlife Conservation Society in collaboration with Wetlands International (Ajonina *et al,* 2003a; Ajonina *et al.*, 2004) in April 2004 showed that numerous waterbirds species abound in mangrove areas where over 30 000 birds representing 60 species were recorded.

THREATS AND DRIVERS OF CHANGE

Key drivers of change in the Cameroon: Population growth and urban development; economic pressure from petroleum exploration.

The majority of the threats facing mangroves are resulting from the key drivers identified above and include:

Urban infrastructure and agricultural development – resulting in the loss of mangrove through clearing. There are conflicting opinions as to the scale of the impact of developments on the mangroves, but it is clear that there is

some level of impact as a result of the clearing (FAO, in press; Din, 2006). Other impacts include pollution from industry, especially oil industries; dredging of canals and rivers to enable transportation, in particular for timber extraction; draining of swamps.

Eutrophication and algal blooms – pesticide and fertilizer run-off from large-scale plantations (rubber, palm oil, banana) in the coastal region of the Cameroon, inhibiting transpiration of the mangrove.

Low protection/legislation for mangroves – recent reports from the field indicate that large tracts of mangrove forests remain unprotected, except within the newly created Ndongoro National Park at the border with Nigeria, Bois de Singe, Douala-Edea National Park, and the Campo Ma'an National Park with the border with Equatorial Guinea. Outside this area the mangroves are threatened with large-scale petroleum/gas exploration and exploitation activities (Ajonina, 2006). In spite of the abundant use of timber and non-timber forest products from the mangroves, an adequate legislation does not exist yet (FAO, in press).

Invasive species – the nipa palm is an introduced species, which has colonized several areas and competes to a significant degree with the indigenous mangroves such as *Rhizophora spp.* (FAO, in press); water hyacinth (*Echorhina crassipes*) is also abundant.

Most of the threats identified are well known but not properly quantified and documented for management applications (Ajonina, 2006).

ECONOMIC ACTIVITY ASSOCIATED WITH MANGROVES

Key uses for mangrove and mangrove forests include:

- Construction of bridges;
- Traditional fishing gear;
- The production of charcoal (in particular, *Rhizophora*);
- Tannins;
- Wine and other distilled beverages from the nipa palm;
- Construction roofing material and decorations;
- Food and medicines;
- Fishing in and around the mangrove, as well as offshore for the mangrove, they are important nursery habitats for fish and shrimp, important for the fishery (Fomete Nembot and Tchanou, 1998);
- Fish processing through smoking with mangrove wood (Fomete Nembot and Tchanou, 1998; Ajonina and Usongo, 2001)

RECENT EVENTS

A training programme was developed to help immigrant fishers from Nigeria sustain their resources, and develop

CWCS modern smoke houses

Gordon Ajonina

improved smoke houses. The CWCS developed ovens that reduce smoking time from 2–3 days to 4–8 hours, also reducing the amount of wood used. The ovens were built from a large spectrum of models provided by the Mangrove Action Project (MAP) in the US, using locally available materials such as adobe-type material, burnt bricks, sand, crushed stones, gravel, wooden rafters and poles, cement, salt, iron rods, wire meshes, and corrugated iron sheets.

The technology is a somewhat modernized variation of the smokehouse, which can be adapted according to the local needs and resources available. It formed the basis for the Edea (4 May–9 May 2003) West and Central regional In the Hands Of Fishers (IHOF) workshop on community-based approaches to fisheries and mangrove management (Ajonina et al., 2003b) with the creation of the African Mangrove Network (www.mangroveafrica.net), organized by the Ministry of Environment and Forests and CWCS under the auspices of MAP (Ajonina, 2006).

9 30'E
10 E
CAMEROON
EQUATORIAL
GUINEA
2 N
2 N
1 30'N
1 30'N
GABON
1 N
1 N
0 6 12 18 24 30 km
9 30'E
10 E

Equatorial Guinea

Land area [km^2]	28 050
Coastline [km]	602.6
Population ['000]	504
Population density [per km^2]	18
Annual population growth rate [%]	2.23
Number of mangrove species in country	2
Total mangrove area [km^2]	258
% of African mangrove cover	1
Estimated change 1980–2006	No change
Mangrove area falling within protected areas [%]	61.6

STATUS

Table of mangrove area estimates

Source Year	**1980**	**1990**	**1997**	**2000**	**2005**	**2006**
Area [km^2]	267	260	277	253	250	258

The most well developed mangroves are found on the deltas of the rivers Mbini, Muni and Ntem. The estuary of Muni is two kilometres wide for its entire length and receives discharge from a number of several secondary rivers. Mangroves occur all the way from the mouth of the estuary up to 17 kilometres inland, and are dominated by *Rhizophora racemosa*. *Avicennia germinans* tends to be found in the more coastal areas (FAO, in press).

There is one confirmed Ramsar Site with mangroves, the Reserva Natural del Estuario del Muni designated on the 2 June 2003 covering 800 square kilometres (1°13'S 9°45'E).

BIODIVERSITY

Just two mangrove species are found in Equatorial Guinea: *Avicennia germinans* and *Rhizophora racemosa* (FAO, in press).

Reserva Natural del Estuario del Muni has young secondary forest and mangroves around the mouths of the rivers, with the red mangrove (*Rhizophora* sp) as well as the black mangrove (*Avicenia* sp). The *Aucoumea klaineana* trees from the *Burseraceae* family also support at least 20 000 waterbirds. The reserve is an important source of food for fish, spawning ground, and nursery and migration path on which fish stocks depend. Fauna includes manatees, elephants, mandrills and migratory birds (Ramsar, 2006c).

THREATS AND DRIVERS OF CHANGE

Key drivers of change in Equatorial Guinea: Rapid development of the oil and gas industry;

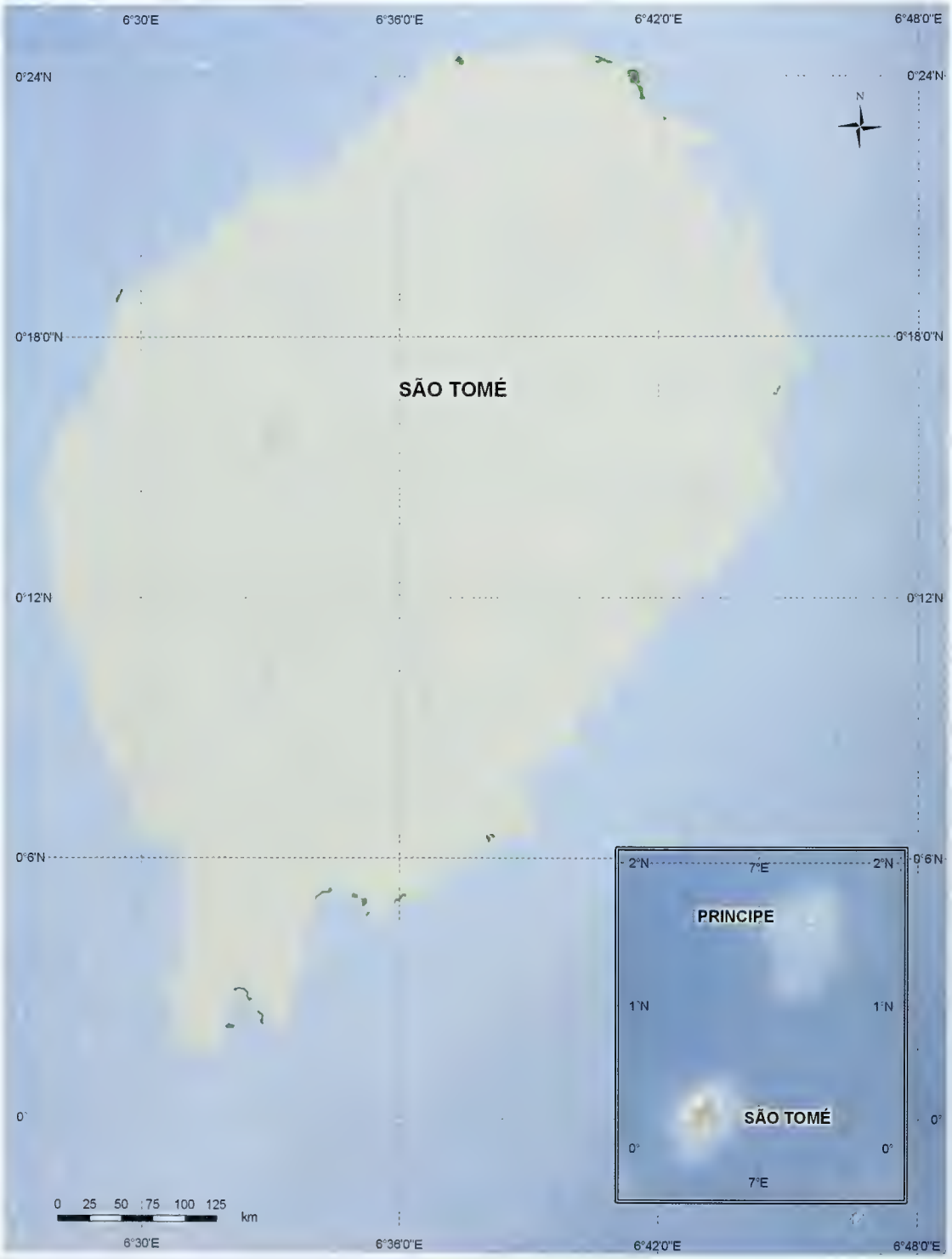
The key threat to mangrove habitats appears to be from the exploration and production of petroleum and gas deposits discovered in the 1990s. Although mangrove forests are exploited by coastal communities, the scale of exploitation does not appear to be unsustainable at current levels of exploitation, although where mangroves are threatened by petroleum activities, this might change. In the Reserva Natural del Estuario del Muni Ramsar reserve, disturbances caused by human activities, such as over-hunting, overfishing, and general forest exploitation threaten the site (Ramsar, 2006c).

ECONOMIC ACTIVITIES ASSOCIATED WITH MANGROVES

Activities can broadly be categorized as industrial and subsistence. Local use of forest and forest products by communities include fishing, hunting, subsistence agriculture, harvest of timber for fuel and construction (FAO, in press; Ramsar, 2006c). The industrial activities since the 1990s have centred on the oil and gas industry, which made Equatorial Guinea the world's fastest-growing economy in 2004 (BBC, 2006a).

RECENT EVENTS

Large oil and gas deposits were discovered off Bioko in the mid-1990s and their exploitation has driven spectacular economic growth in the country (BBC, 2006a).


6°30'E
6°36'0"E
6°42'0"E
6°48'0"E
0°24'N
0°18'0"N
0°12'N
0°6'N
0°
N
SÃO TOMÉ
2°N
7°E
PRINCIPE
1°N
SÃO TOMÉ
0°
0 25 50 75 100 125
km

São Tomé and Príncipe

Land area [km^2]	960
Coastline [km]	269.0
Population ['000]	157
Population density [per km^2]	162
Annual population growth rate [%]	2.16
Number of mangrove species in country	4
Total mangrove area [km^2]	1.40
% of African mangrove cover	<0.1
Estimated change 1980-2006	No Data
Mangrove area falling within protected areas [%]	0

STATUS

Table of mangrove area estimates

Source Year	**1980**	**1990**	**1997**	**2000**	**2005**	**2006**
Area [km^2]	No data	No data	No data	No data	No data	1.40

The island group of São Tomé and Príncipe consists of two main islands of volcanic origin and a number of smaller islets (BBC, 2006b). The islands are separated from the African mainland by water up to 1800 metres deep and have never been connected to the continent (World Bank, 1993). The FAO currently have no quantitative information available for this country. However, the National Biodiversity Action Plan indicates the presence of small mangrove stands in the estuaries of Shell Beach, Tamarinos Beach, Pantufo, Izé Water, Malanza Lagoon and in Lapa, on the island of São Tomé (Ministerio de Recrusos Naturais y Meio Ambiente, n.d.).

BIODIVERSITY

On all of the islands in the Gulf of Guinea the species of mangrove that grows there belong mainly to *Rhizophora* spp. One of the zones of mangrove is called Mangrove of Pantufo (FAO, in press).

There is an area called Mangrove de Malanza at the extreme South of São Tomé, which is characterized by *Acrostichum aureum; Cyperaceaes (Sleria depressa)* (EC, 1999).

THREATS AND DRIVERS OF CHANGE

Key drivers of change in São Tomé and Príncipe: Coastal development

Evidence has been found of threats (Ministerio de Recrusos Naturais y Meio Ambiente, n.d.) including:

- Coastal erosion and infrastructure development;
- Inappropriate fishing methods;
- Residual oil polluting coastal environments from the high seas;
- Discharge of the petrol residues into the estuary of the River Grande;

ECONOMIC ACTIVITY ASSOCIATED WITH MANGROVES

São Tomé and Príncipe is trying to reduce its dependence on cocoa; falls in production and prices left the island state heavily reliant on foreign aid. The government has been encouraging economic diversification and is currently investigating the exploitation of oil thought to lie off the country's coast. Exploration is underway and commercial production is expected to begin within a few years (BBC, 2006b).

RECENT EVENTS

Data on the status of the mangroves in São Tomé and Príncipe is scarce, but there are indications that much of the coastal mangrove forest was destroyed just before 1990 (UNEP, 1990).

9 E
10 30'E
12 E
EQUATORIAL GUINEA
N
0°
0°
GABON
1°30'S
1°30'S
3°S
3°S
CONGO
0 40 60 80 100
km
9 E
10°30'E
12 E

Gabon

Land area [km²]	257 670
Coastline [km]	2 019.1
Population ['000]	1 384
Population density [per km²]	5
Annual Population Growth Rate [%]	1.58
Number of mangrove species in country	7
Total mangrove area [km²]	1 606
% of African mangrove cover	5
Estimated change 1980–2006	Moderate decline
Mangrove area falling within protected areas [%]	42.9

STATUS

Table of Mangrove area estimates

Source Year	**1980**	**1990**	**1997**	**2000**	**2005**	**2006**
Area [km²]	2 185	1 858	1 759	1 529.4	1 500	1 606

Gabon is considered to be one of Africa's most stable countries. Its president, Omar Bongo, has been in power since 1967 and his pro-environment stance is thought to have had a positive impact on the country's mangroves (Quammen, 2003).

In Gabon, the dominant currents come from the openings of the rivers towards the north and the mangroves thus develop along the coastal margins, moving north. Mangrove forests are found in all estuaries, bays and lagoons along the coast to some extent and are generally located on left banks. The principal mangrove formation is found in the mouth of Como and covers an area of 850 square kilometres (Vande Weghe, 2006) – with Libreville on the right bank of the estuary – near Ogooué (FAO, in press). Another significant area of mangrove is the Bay of Mono with 350 square kilometres of mangroves (Vande Weghe, 2006).

Gabon has three Ramsar Sites with mangroves (designated on 30 December 1986). These are:

Wongha-Wonghé. Covering 3800 square kilometres (00°45'S 009°25'E); with little mangrove present (Vande Weghe, 2006).

Petit Loango. Covering 4800 square kilometres (02°15'S 009°45'E), but now included in Loango NP (Vande Weghe, 2006), and

Setté Cama. Covering 2200 square kilometres (02°40'S 010°05'E), now included in Loango NP (Vande Weghe, 2006).

BIODIVERSITY

Seven species of mangrove occur in Gabon:

Acrostichum aureum
Avicennia germinans
Conocarpus erectus
Laguncularia racemosa
Rhizophora harrisonii
Rhizophora mangle
Rhizophora racemosa

Rhizophora racemosa, R. harrisonii, R. mangrove species tend to dominate the seaward stands, whilst *Avicennia germinans, Acrostichum aureum, Conocarpus erectus* and *Laguncularia racemosa* dominate the less flooded zones and the dry fringes in the transition to terrestrial forests (Vande weghe, 2006). In the Akanda National Park, and western Pongara National Park, the mangroves are marine formations with mostly low, open *Rhizophora*. Tall *Rhizophora* are only found in narrow stands along the rivers and the large areas of hypersaline bare soil (tannes). The eastern mangroves of *Pongara,* which grow in brackish water with a lot of sediment, are much taller and may grow up to 30 metres. Palms (Raphia and Phoenix) are found in the transition zone with the terrestrial forests.

In the Bay of Lopez, the mangroves are intermediate in size. They are mainly short *Rhizophora* stands with tall *Rhizophora* along the rivers but in a wider belt than in Akanda National Park. In the Fernan-Vaz part of the delta, tall Rhizophora stands abound, as in the eastern part of the Como Estuary. In Sette Cama, the mangroves along the outlet of the Ndugu laguna are pure *Avicennia* (Vande weghe, 2006).

The Ogooué delta is one of the largest, most intact and least known mangrove and freshwater swamp systems in Sub-Saharan Africa, containing a unique assemblage of plants and animals, including populations of aquatic mammals such as hippopotamus and manatee and many species of waterbirds (UNEP/Nasi, 2001). Other species found in Gabon's mangroves include:

- Over 40 000 Palaearctic waders counted in January 1983. (Vande weghe, 2006);
- Two species of soft-shell turtle (Loango National Park) (GBP, 2003);
- Cattle egret (*Bubulcus ibis*) (GBP, 2003);
- *Aristogeitonia gabonica (Picrodendraceae);*
- The warbler *Apalis flavida,* which locally only occurs in mangroves and coastal scrub (Vande weghe, 2006);
- The chimpanzee *Pan troglodytes*, gorilla *Gorilla gorilla*

Map 3: National Park system for Gabon (Quammen, 2003)

gorilla, elephant *Loxodonta africana* and white pelican *Pelecanus onocrotalus* (Ramsar, 2006b).

THREATS AND DRIVERS OF CHANGE

Key drivers of change in Gabon: development associated with petroleum and gas exploration and production.

Current information suggests the mangroves of Gabon are not commercially exploited, and are currently utilized at subsistence levels (FAO, in press; Vande weghe, 2006).

Suggestions of two sources of threats to mangrove ecosystems in Gabon that have been identified:

(i) Unsustainable practices of migrant fishers originating from Nigeria (Vande weghe, 2006).

(ii) Impacts, intentional or accidental, as a result of oil exploration (Ramsar, 2006b).

ECONOMIC ACTIVITY ASSOCIATED WITH MANGROVES

The Gabonese *oil industry* is the key economic resource for the country. Oil is considered its most important natural resource because it is the major source of foreign

exchange and makes up the majority of exports. The downstream oil industry is also well developed with an oil refinery at Port Gentil and a number of international oil companies active in the distribution and marketing of petroleum products. Gabon also has an active *manganese mining industry* (Mbendi, 2003).

Eco-tourism to the country is expected to increase in significance in future years as the country's oil reserves become depleted (Quammen, 2003).

Hunting parties for the guests of the president are undertaken at the Wonga-Wongué reserve. Access is strictly limited and anti-poaching management measures are undertaken (Ramsar, 2006b).

No information has been found regarding traditional subsistence use of mangroves by coastal communities; however, it is assumed that such activities are carried out, but at a level not currently of concern.

RECENT EVENTS

An extensive national park system, including coastal areas, was gazetted in 2002 (see Map 3), hailed by some as one of the most significant conservation actions since the establishment of the first National Park in 1872. This system includes mangroves in the extreme south-west of the country, Mayumba National Park, an IUCN Category II Protected Area (Quammen, 2003).

11 30 E
GABON
GABON
12 E
4 S
4 S
CONGO
4 30'S
4 30'S
5 S
5 S
ANGOLA
0 6 12 18 24 30
km
11 30'E
12 E

Congo

Land area [km²]	341 500
Coastline [km]	205.1
Population ['000]	3999
Population density [per km²]	12
Annual population growth rate [%]	2.94
Number of mangrove species in country	6
Total mangrove area [km²]	17
% of African mangrove cover	<0.1
Estimated change 1980-2006	Severe decline
Mangrove area falling within protected areas [%]	1.1

STATUS

Table of mangrove area estimates

Source Year	**1980**	**1990**	**1997**	**2000**	**2005**	**2006**
Area [km²]	200	120	188	83.5	80	17

The extent of mangroves in Congo is limited, and according to available data, declining rapidly. They are found along the coastal estuaries and lagoons (FAO, in press), particularly the Kouilou, Noumbi and Loémé estuaries; in the Conkouati-Douli National Park along the Conkouati, Mékoundji, Mvassa, Malondo, Yombo and Bouloumouka lagoons; and along the rocky shores of Mvassa. Stands are becoming increasingly fragmented, areas as small as one square kilometre in the smaller lagoons (FAO, in press).

The mangrove forests of Congo can be separated into four groups (FAO, in press):

(i) *high forests* with tree canopies reaching 20–25 metres (Kouilou and Noumbi rivers, Conkouati lagoon);
(ii) *closed forests* which reach 8–15 metres in height (Mékundji, Yombo, Malonda and Loémé);
(iii) mangrove forest mosaics, interspersed with non-mangrove trees, reach a maximum of 10 metres in height (Mvassa, Loya, Bulumuka, Vandji and other small lagoons);
(iv) *degraded stands* with trees that reach 3–5 metres (Songolo and Loubi). The tide reaches 30 kilometres up several Congolese rivers.

The growth of mangroves in Congo is slowed by the long dry season, which lasts from June to September, and the presence of cold-water current, which passes not far from the Congolese coasts (FAO, in press).

BIODIVERSITY

Six of the eight species of West African mangroves are present in the Congo:

Acrostichum aureum
Avicennia germinans
Conocarpus erectus
Laguncularia racemosa
Rhizophora harrisonii
Rhizophora racemosa

The dominant species is *Rhizophora racemosa*, although it is rarer upriver and eventually merges with the freshwater palm tree *Phoenix reclinata*, papyruses or marshy forests of fresh water (FAO, in press). A small stand of *Avicennia germinans* occurs along the rocky shore.

THREATS AND DRIVERS OF CHANGE

Key drivers of change in the Congo: population increase and civil unrest.

The reduction of extent and quality of mangrove ecosystems in the Congo has been due principally to the uncontrolled urbanization of the coast in the south-east of the country, which is home to 70 per cent of the population, and the subsequent unmanaged exploitation of mangrove resources for firewood and fishing. In some zones of the country, such as the Songolo lagoon and the forests of Loya and Mvassa, where the mangroves are now forest relics, the construction of homes is the principal cause of this degradation.

Pollution, caused by hydrocarbon exploitation, threatens these ecosystems, and some of the coastal lagoons are polluted by this industry (FAO, in press; WCS, 2006). The mangroves that are near Point-Black (Loya, Songolo, Mvassa and Loubi) are seriously degraded by oil slicks. The lagoons of Loubi, Loya and Songolo have also been affected by chemical pollution.

Although the forests of Congo are protected from the legal point of view, controls are still inadequate (FAO, in press). Civil unrest in the country during the late 1990s affected industrial and commercial activities and undermined management of natural resources.

ECONOMIC ACTIVITY ASSOCIATED WITH MANGROVES

Petrochemicals: the Congo's economy is based primarily on the petroleum sector, which is by far the country's major

revenue earner. The country's abundant rainforests are the source of timber.

Commercial forestry, which led Congolese exports before the discovery of oil, now generates less than 7 per cent of export earnings. Wood production came to a standstill during the war, but has recommenced and new concessions were leased in 2001 (United States Department of State, 2006b).

Subsistence activities: the local communities depend heavily on mangroves to the degree of overexploitation of these resources, resulting in negative impacts on the health and functioning of the mangrove ecosystems in some areas. However, there are still intact forests such as those of Mékundji, Vandji and Noumbi, and several awareness-raising initiatives have been initiated within the dependent populations on the importance of the sustainable use of these resources reduce food insecurity.

RECENT EVENTS

In March 2006, Ramsar signed a memorandum of cooperation with the Commission Internationale du Bassin Congo-Oubangui-Sangha (CICOS). CICOS was created in 1999 by the Heads of State of Cameroon, Central African Republic, Republic of Congo, and the Democratic Republic of the Congo as an intergovernmental organization charged with managing the waterways of the region sustainably and promoting integrated water resources management for the Congo-Oubangui-Sangha Basin. Mangroves fall under its mandate and provide a mechanism to address mangrove conservation in the region (Ramsar, 2006b).

Democratic Republic of the Congo

Land area [km²]	2 267 050
Coastline [km]	176.8
Population ['000]	57 549
Population density [per km²]	25
Annual population growth rate [%]	3.08
Number of mangrove species in country	6
Total mangrove area [km²]	201
% of African mangrove cover	0.7
Estimated change 1980–2006	Severe decline
Mangrove area falling within protected areas [%]	25

STATUS

Table of mangrove area estimates

Source Year	1980	1990	1997	2000	2005	2006
Area [km²]	606	353	374	220	220	201

The Democratic Republic of the Congo is a vast country that straddles the equator. The Congo River basin covers an area of almost one million square kilometres (CIA, 2006). Despite the country's size, the length of its maritime coast is no more than 40 kilometres, including the lower Congo River, its only outlet to the Atlantic Ocean (CIA, 2006; FAO, in press). The coast is characterized by elevated reefs and mangroves, which occupy the breeches of the cliff and form one of the most important mangroves zones in the Congo Delta (FAO, in press).

Mangrove forests in 1994 were recorded by Service Permanent d'Inventaire et d'Aménagement Forestiers as covering 555.57 square kilometres, which equated to 0.04 per cent of forests in DCR and 0.02 per cent of the land area. This is significantly higher than the estimates since 1980 presented above, possibly as a disparity in the definition of mangrove forest. Based on information presented in this report, indications are that mangrove cover has decreased by two thirds since 1980.

The World Resources Institute (WRI) reported that no mangroves in the country were protected in the 1990s (WRI, 2003b), however, the DCR reported to Ramsar's 7th Conference of the Parties (COP) the establishment of a Ramsar Site created under Ministerial decree No.44/CM/ECN/92 (2 May 2002) by the Ministry of the Environment, Nature Conservation and Tourism (Tshibasu, n.d.). The reserve was designated especially to protect mangroves (http://www.ramsar.org/cop7/cop7_nr_congo_dr.htm).

The Parc Marin des Mangroves was designated as a Ramsar site on 18 January 1996 and covers an area of 660 square kilometres (05°45'S 012°45'E). The site is protected at the national level under law number 75-023 (22 July 1975), modified by ordinance number 78-190 (5 May 1978) according to the statute of the institute. The objective is to ensure the protection of flora and fauna within the reserves of the DRC and to enable scientific research and tourism in respect of the fundamental principals of nature conservation and management (Tshibasu, no date).

BIODIVERSITY

Six species of mangrove are present in the DCR:

- *Acrostichum aureum*
- *Avicennia germinans*
- *Conocarpus erectus*
- *Laguncularia racemosa*
- *Rhizophora mangle*
- *Rhizophora racemosa*

The intertidal forests are dominated by *Rhizophora racemosa*, *Rhizophora harrisonii*, and *Rhizophora mangle* in the intermediate zone. The first two species can reach 25–30 metres in height (FAO, in press). Nine species of rare or endangered mammals (including manatee), six bird and eight reptile species (including marine turtle) are at risk from the destruction of their habitats in the Maritime Park predominately as a result of irrational resource utilization.

THREATS AND DRIVERS OF CHANGE

Key drivers of change in DCR: economic development (petrochemical) and habitat modification.

The river delta is sparsely populated and the mangroves are not too degraded. There are three key threats to mangroves in this region:

- Deforestation;
- Poaching (principally of turtles and manatee (endemic));
- Hydrocarbon pollution (primarily originating from the Cabinda region of Angola (FAO, in press), but also from tankers (Tshibasu, n.d.)).

Within the Parc National des Mangroves, threats to the habitat are from:

- *Subsistence use* – gathering of medicinal plants, cutting of fuelwood and the production of subsistence crops;

CONGO, DRC
ANGOLA
ANGOLA
12 E
12 240'E
12 480'E
13 120'E
5 360'S
6 000'S
6 240'S
0 5 10 15 20 25 km

- *Pollution* from oil refining;
- *Urban and industrial development* of the Congo River estuary and the Moanda region, development by the Regie des Voies Maritimes (Seaways Board) of transport infrastructures, and development of the Banana deep-water harbour (Ramsar, 2006b).

ECONOMIC ACTIVITIES AND INDUSTRY

Industrial activity is currently low in mangrove areas. The Parc National des Mangroves site is state-owned and has important fish and crustacean reserves for local fisheries. In the surrounding area there is subsistence farming, hunting and harvesting of wild foods. These are mainly used for medicinal purposes (Ramsar, 2006b).

The DCR has undertaken a cost-benefits analysis to understand and demonstrate the values that are attached to some coastal wetlands by local communities. This proved to be a powerful tool in assisting decision-makers when they decided to establish the Parc National des Mangroves (Ramsar, 1999).

CONGO
ANGOLA
CONGO,
DRC
ANGOLA
12°E
14°E
6°S
8°S
10 S
12 E
14°E
0 20 40 60 80 100
km

Angola

Land area [km^2]	1 246 700
Coastline [km]	2 251.8
Population ['000]	15 941
Population density [per km^2]	13
Annual population growth rate [%]	2.79
Number of mangrove species in country	3
Total mangrove area [km^2]	333
% of African mangrove cover	1
Estimated change 1980–2006 [%]	Moderate decline
Mangrove area falling within protected areas [%]	11

STATUS

Table of mangrove area estimates

Source Year	1980	1990	1997	2000	2005	2006
Area [km^2]	530	433	607	336	330	333

Mangroves are found along the estuaries of Angola's major rivers. The most significant stands are found on the estuary of Lubinda, around the enclave of Cabinda and on the Congo estuary, bordering the Democratic Republic of the Congo. From here, the mangroves extend southwards with declining diversity. Other stands are found at the mouth of the Chiluango, Bambongo, Longa and Cuanza rivers. Mangroves do not occur below Benguela, as the coast becomes more arid and sea-surface temperatures decline, resulting in an abrupt change in vegetation from tropical to temperate species at Santa Maria (FAO, in press).

There are no sites designated under the Ramsar Convention, however, there are two nationally designated protected areas containing mangrove habitats: Kisama National Park and Ilha dos Passaros Integral Nature Reserve (Great Barrier Reef Marine Park Authority/The World Bank/The World Conservation Union, 1995).

BIODIVERSITY

Diversity of mangrove species declines from north to south. The size of a given species also declines moving south. In the northern part of Angola, *Rhizophora racemosa* and *R. mangle* reach a height of 30 metres, while in the south they do not exceed a metre, likewise southern *Avicennia germinans* vegetation is usually quite scrubby (FAO, in press).

The mangrove ecosystems in Angola create unique habitats and host some rare species, including primates such as the blue guenon (*Cercopithecus mitis*); the talapoin (*Miopithecus talapoin*); the Bosman's potto (*Perodicticus potto*) and bush babies (*Galago* spp.). On the lower courses of mangrove-lined rivers the African manatee (*Trichechus senegalensis*) is found, as well as the soft-skinned turtle (*Trionyx triunguis*) (MANGAIS ECO-TURISMO, n.d.).

The Quiçama Important Bird Area (IBA) extends along 110 kilometres of the Angolan coast. It holds a diversity of bird habitats, including the most southern patch of extensive mangrove forest in Angola, located in the Cuanza estuary (BirdLife International, 2005). The Mussulo IBA is dominated by mangroves. Species found here include *Rhizophora mangle*, *Laguncularia racemosa* and *Avicennia germinans*. The site is important for aquatic birds, with 61 congregatory waterbird species (42 per cent of Angolan list) recorded (BirdLife International, 2005). The mangrove ecosystem of Mussulo is not represented in mangrove communities elsewhere on the Angolan coast and their botanical interest alone has been used to justify its conservation (Huntley, 1974).

THREATS AND DRIVERS OF CHANGE

Key drivers of change in Angola: political unrest; economic development.

A substantial threat to mangroves is the collecting of the fuelwood, which has deforested or seriously disturbed many systems. In the area of Cabinda, hydrocarbon prospecting disturbed mangrove formations (FAO, in press).

Mangrove forests on Mussulo are currently being felled for housing and are likely to be totally destroyed within a relatively short time (BirdLife International, 2005).

ECONOMIC ACTIVITY ASSOCIATED WITH MANGROVES

Angola is one of Africa's major oil producers with exports to the United States and China. Other subsistence activities include the use of mangrove wood for construction and fuelwood. Little information could be found describing use of mangrove habitats in Angola.

RECENT EVENTS

Angola's 27-year-old civil war ended in 2002. Much of Angola's oil wealth lies in Cabinda province, where a decades-long separatist conflict still exists and habitats of mangroves remain (BBC, 2006c).

Annex 1: References

Adite, A. 2002. *The Mangrove Fishes in the Benin Estuarine System (Benin, West Africa): Diversity, Degradation and Management Implications.* Available at http://iodeweb1.vliz.be/odin/handle/1834/455?mode=full&submit_simple=Show+full+item+record

African Birding Club 2005. Guinea Bissau. African Birding Resources. Available at http://www.africanbirdclub.org/countries/GuineaBissau/conservation.html (accessed 5 July 2005).

African Conservation Foundation n.d. *Profile on Equatorial Guinea.* Available at http://www.africanconservation.org/equatorialguineaprofile.html (accessed 4 July 2006).

AFROL 2002. Mangroves of Western Africa threatened by Global Warming. In: *Afrol News.* Available at http://www.afrol.com/Categories/Environment/env019_mangroves_threatened.htm (accessed 18 July 2006).

Airy Shaw, H.K. 1947. The Vegetation of Angola. *The Journal of Ecology* 35 (1/2): 22–48.

Ajonina, G.N. 2006. Personal communication via email re: West African Mangrove Report. 27 July 2006.

Ajonina, G.N., Ayissi, I. and Usongo, L. 2004. *Inventory of Coastal Wetlands of Cameroon/Inventaire des Zones Humides Côtieres du Cameroun.* Wetlands International report.

Ajonina, G., Ganzevles, W. and Trolliet, B. 2003a. Rapport national du Cameroun. In: Dodman T. and Diaguna, C.H. African waterbird census/les dénombrements d'oiseaux d'eau en Afrique 1999, 2000 et 2001. *Wetlands International Global Series* 16.

Ajonina, G., Kuete, F., Mekongo, F. and Ayissi, I. (eds) 2003b. *Proceedings of the 6th regional In Hands Of Fishers (IHOF) workshop on community-based approaches to fisheries and mangrove management/Rapport du 6e atelier régional IHOF sur les approches communautaires de gestion de la mangrove et des activités de pêche.* Edea, Cameroon.

Ajonina, G. and Usongo, L. 2001. Preliminary quantitative impact assessment of wood extraction on the mangroves of Douala-Edea Forest Reserve, Cameroon. *Tropical Biodiversity 7 (2–3): 137–149.*

ANCE (National Consumer And Environmental Alliance of Togo). 2005. *Brief Resume of Activities Carried out on Mangroves Conservation In Togo.* Environment Division.

Arfi, R., Dufour P. and Maurer, D. 1981. Phytoplancton et pollution. Premières études en baie de Biétri (Côte d'Ivoire). Traitement mathématique des données. *Oceanologica Acta* 4: 319-329.

Armah, A.K. 2006. Personal communication via email re: West African Mangroves – Ghana AK Armah. 26 July 2006.

Baba, S.; Gordon, C.; Kainuma, M.; Ayivor, J.S.; Dahdouh-Guebas, F. (2004). The Global Mangrove Database and Information System (GLOMIS): present status and future trends. In: Van den Berghe, E., *et al.* (ed.) (2004). *Proceedings 'The Colour of Ocean Data': international symposium on oceanographic data and information management with special attention to biological data Brussels, Belgium, November 25–27, 2002.* IOC Workshop Report 188: pp. 3–14.

Bandarayake, W. 1997. Mangroves And Their Products. Available at http://www.fao.org/docrep/W7700E/w7700e04.htm. Accessed 20 July 2006.

BBC. 2006a. Country Profile: Equatorial Guinea. Available at http://news.bbc.co.uk/1/hi/world/africa/country_profiles/1023151.stm#overview (accessed 6 July 2006).

BBC. 2006b. Country Profile: Sao Tome and Principe. Available at http://news.bbc.co.uk/1/hi/world/africa/country_profiles/1064541.stm (accessed 6 July 2006).

BBC. 2006c. Country Profile: Angola. Available at http://news.bbc.co.uk/1/hi/world/africa/country_profiles/1063073.stm (accessed 6 July 2006).

Binet, D., Le Reste, L. and Samba Diouf, P. 1995. The Influence of Runoff and Fluvial Outflow on the Ecosystems and Living Resources of West African Coastal Waters. Available at http://www.fao.org/DOCREP/003/V4890E/V4890E04.htm (accessed 27 July 2006).

BirdLife International. 2005 BirdLife's online World Bird Database: the site for bird conservation. Version 2.0. Cambridge, UK: BirdLife International. Available at http://www.birdlife.org (accessed 19 July 2006).

Blasco, F., Carayon, J.L. and Aizpuru, M. 2001. World Mangrove Resources. *GLOMIS Electronic Journal.* 1(2):July 2001. Available at http://www.glomis.com/ej/pdf/ej02.pdf

Carrere, R. 2002. *Mangroves: Local Livelihoods vs. Corporate Profits.* World Rainforest Movement.

Central Intelligence Agency (CIA). 2006. CIA World Factbook. Available at https://www.cia.gov/cia/publications/factbook/index.html (accessed 3 July 2006).

Chape, S., Harrison, J., Spalding, M. and Lysenko, I. 2005. Measuring the extent and effectiveness of protected areas as an indicator for meeting global biodiversity targets. *Philosophical Transactions of the Royal Society B: Biological Sciences* 360 (1454): 443–455.

CNN. 2006. China's African Safari. In CNN Money News. Available at http://money.cnn.com/magazines/fortune/fortune_archive/2006/02/20/8369153/index.htm. Accessed 18 July 2006.

Dahdouh-Guebas, F. and Koedam, N. 2001. Are the northernmost mangroves of West Africa viable? – a case study in Banc d'Arguin National Park. Mauritania. *Hydrobiologia* 458: 241–253.

Department of Parks and Wildlife Management. 1998. The Gambia National Biodiversity Strategy and Action Plan. Available at http://www.biodiv.org/doc/world/gm/gm-nbsap-01-en.pdf (accessed 30 June 2006).

DFID. 1996. Lower Volta mangrove project: phase 1: assessment of environmental, economic and social factors. Available at http://www.odi.org.uk/tropics/projects/2276.htm#UK (accessed May 2007).

Din, N. 2003. Gestion durable des mangroves sous pression démographique et pauperisation. World Forestry Congress. Available at www.fao.org/DOCREP/ARTICLE/WFC/XII/0394-B2.HTM (accessed 26 July 2006).

Din, N. 2006. Personal communication via email re: West African Mangrove Report. 27 July 2006.

Din, N. and Blasco, F. 1998. Mangroves du Cameroun, statut écologique et déforestation. In: Vicat, J.P. and Bilong, P. (eds). *Géosciences au Cameroun.* Presses Univ. Cameroun, Yaoundé. pp. 15–22.

Diop, E.D. (ed.) 1993. Conservation and Sustainable Utilization of Mangrove Forests in Latin America and Africa Regions. Part II – Africa. International Society for Mangrove Ecosystems and Coastal marine Project of UNESCO. *Mangrove Ecosystems Technical Reports* 3.

Dodman, T., Barlow, C., Sá, J. and Robertson, P. (2004). *Zonas Importantes para as Aves na Guiné-Bissau / Important Bird Areas in Guinea-Bissau.* Wetlands International, Dakar.

Dufour, P. and Slepoukha, M. 1975. L'oxygène dissous en lagune Ebrié: influence de l'hydroclimat et des pollutions. *Doc. Sci. Cent. Rech.Océanogr. Abidjan ORSTOM* 6: 75–118.

Ekweozor, I.K.E. 1989. A review of the effects of oil pollution in a West African environment. *Discovery and Innovation: Nairobi* 1(3): 27–37. Available at http://www-wds.worldbank.org/servlet/WDSContentServer/WDSP/IB/2000/11/10/000094946_00082605382642/Rendered/INDEX/multi_page.txt

Elijah, A. 2001. Strategies for the sustainable management of mangrove resources in the Niger Delta. Discussion paper.

Ellison, A.M. and Farnsworth, E.J. 1997. Simulated sea level change alters anatomy, physiology, growth, and reproduction of red mangrove (*Rhizophora mangle L.*). *Oecologia* 112: 435–446.

European Commission (EC). 1999. *Finalisation des Plans D'aménagement des Parcs Nationaux Ôbo de Sao-Tome & Ôbo Principe.* Seca.

European Commission (EC). 2003. *Senegal's mangrove forests: problems and prospects.* Country Report. Available at http://ec.europa.eu/comm/development/body/publications/courier/courier196/en/en_069.pdf (accessed 03 July 2006).

FAO. 1994. *Mangrove forest management guidelines.* FAO Forestry Paper 117. Rome.

FAO. 2000. In press: Food crisis through warfare in Sierra Leone, Guinea and Liberia. Available at www.afrol.com/News2001/sil012_gui_lib_food.htm (accessed 27 July 2006).

FAO. 2006. Conserving Cameroon's mangroves. FAO Newsroom. Available at www.fao.org/newsroom/en/field/2006/1000260/index.html (accessed 5 July 2006).

FAO. In press. Global Forest Resources Assessment 2005. Thematic Study on Mangroves. Rome.

FAO. n.d. Forest Resources Of Tropical Africa. In: *FAO Corporate Document Repository.* Available at www.fao.org/docrep/007/ad909e/AD909E03.htm (accessed 4 August 2006).

Fomete Nembot T. and Tchanou, Z. 1998. *La gestion des écosystèmes forestiers du Cameroun a l'aube de l'an 2000,* tome 2. (Monographie des sites critiques et annexes). CEFDHAC — Processus de Brazzaville. IUCN,Yaoundé, Cameroun. Available at http://carpe.umd.edu/products/PDF_files/Report-Nembot1998Vol2.pdf

Gatter, W. 1988. *Coastal Wetlands of Liberia: their Importance for Wintering Waterbirds.* International Council for Bird Preservation, Cambridge, UK.

GBP. 2003. Gabon Biodiversity Programme Biodiversity Research, Monitoring and Training in the Gamba Complex 2003. Available at http://nationalzoo.si.edu/ConservationAndScience/MAB/researchprojects/appliedconservation/gabon/GabonBriefingPaper6.pdf (accessed 8 August 2006).

GEF. 2002. Côte d'Ivoire Coastal Zone Phase 1: Integrated Environmental Problem Analysis. GEF MSP Sub-Saharan Africa Project (GF/6010-0016): "Development and Protection of the Coastal and Marine Environment in Sub-Saharan Africa".

GIWA. 2006. Freshwater Shortages, Engineering of River Flows, Pollution and Overfishing Highlighted in Final Global International Waters Assessment. Available at http://www.unep.org/Documents.Multilingual/Default.Print.asp?DocumentID=471&ArticleID=5234&l=en (accessed 30 June 2006).

Gordon, C. 2005. *Principles For A Code Of Conduct For The Sustainable Management Of Mangrove Ecosystems.* Centre for African Wetlands. Available at http://mit.biology.au.dk/cenTER/MCB_Files/Ramsar/2005_Ramsar_Arusha_V2.pdf (accessed 21 July 2006).

Government of Liberia. 2004. CBD Strategy and Action Plan – Liberia (Part I, English version). Available at www.biodiv.org/doc/world/lr/lr-nbsap-01-p1-en.doc (accessed 30 June 2006).

Government of Sierra Leone. 2003. National Biodiversity Strategy and Action Plan. Available at http://www.biodiv.org/doc/world/sl/sl-nbsap-01-en.pdf (accessed 30 June 2006).

Government of the Republic of Guinea: Ministry of Mines, Geology, and the Environment. 2002. National Strategy and Action Plan for Biological Diversity. CBD Strategy and Action Plan – Guinea Part 1, English version. http://www.biodiv.org/doc/world/gn/gn-nbsap-01-p1-en.doc (accessed 4 July 2006).

Great Barrier Reef Marine Park Authority/The World Bank/The World Conservation Union (IUCN). 1995. A Global Representative System of Marine Protected Areas. Marine region 8: West Africa. Available at http://www.deh.gov.au/coasts/mpa/nrsmpa/global/volume2/chapter8.html (accessed 03 August 2006).

Hearn, G.W. 2006. Personal communication via email re: Mangrove usage in Bioko, Equatorial Guinea. 20 July 2006.

Hoffmann, L. 1988. The Banc d'Arguin: nature in harmony with man. *WWF News.* June/July: 10–11.

Huntley, B.J. 1974. Outlines of wildlife conservation in Angola. *Journal of the Southern African Wildlife Management Association* 4: 157–166.

IPCC. 2000. Special Report on The Regional Impacts of Climate Change: An Assessment of Vulnerability. Africa Chapter. Available at www.grida.no/climate/ipcc/regional/006.htm (accessed 14 July 2006).

International Development Research Centre, Project profile: Mangrove Salt (Guinea). 1990. http://www.idrc.ca/en/ev-83047-201_890293-1-IDRC_ADM_INFO.html (accessed 8 August 2006).

Isebor, C.E. and Awosika, L.F. 1993. Nigerian Mangrove Resources, Status and Management. In: Diop, E.D. (ed.) *Conservation and Sustainable Utilization of Mangrove Forests in Latin America and Africa Regions. Part II – Africa.* International Society for Mangrove Ecosystems and Coastal Marine Project of UNESCO. Mangrove Ecosystems Technical Reports 3.

ISME, Center Aarhus. 2003. Draft Code of Conduct for the Sustainable Management of Mangrove Ecosystems. CenTER Aarhus, Denmark. Available at http://mit.biology.au.dk/cenTER/MCB_Files/MCB_DC_WS_Rep_FINAL_081104.pdf

IUCN. 1994. Guinea-Bissau: Coastal Planning. IUCN/MDRA/DGFC Information Document.

IUCN/WWF. 1989. Technical Evaluation: Banc d'Arguin National Park. IUCN, Gland, Switzerland.

John, D.M., Lawson, G.W. 1990. A review of mangrove and coastal ecosystems in West African and their possible relationships. *Estuarine, Coastal and Shelf Science.* 31(5): 505–518.

Johnson, D., Blivi, A., Houedakor, K., Kwassi, A., Sena, N. 2001. Le littoral du Togo: données et gestion intégrée. Centre de Gestion Intégrée du Littoral et de l'Environnement. Université de Lomé, Togo, Guinea. Available at http://www.coastgis.org/01pdfs/johnson.pdf

Kathiresan, K. and Bingham, B.L. 2001. Biology of mangroves and mangrove ecosystems. *Advances in Marine Biology* 40: 81–251.

Kaufman, L. n.d. Personal communication cited in: Shumway, C.A. 1999. *Forgotten Waters: Freshwater and Marine Ecosystems in Africa.* Strategies for Biodiversity Conservation and Sustainable Development.

Kodjo, E.A. 2006a. Personal communication via email. 26 July 2006.

Kodjo, E.A. 2006b. *The Mangroves of Togo Are Disappearing.* Topic #48. Available at http://www.africanconservation.org/dcforum/DCForumID29/48.html (accessed 21 July 2006).

Laë, R; Ecoutin, J-M.; Mendy, A.; Raffray, J.; Weigel, Jean-Yves; Sadio, O.; Djobe, O. 2004. Effects of a targeted shrimp (*Penaeus notialis*) exploitation on fish catches in the Gambia estuary. Aquatic Living Resources 17: 75–85. Available at http://www.edpsciences.org/articles/alr/pdf/2004/01/alr10.pdf?access=ok (accessed 19 July 2006).

Macintosh, D.J. and Ashton, E.C (eds). 2003. Report on the Africa Regional Workshop on the sustainable management of mangrove forest ecosystems. ISME/cenTER/CAW.

McLean, R.F., Tsyban, A., Burkett, V., Codignotto, J.O., Forbes, D.L., Mimura, N., Beamish, R.J., Ittekkot, V. 2001. Coastal zones and marine ecosystems. In: Bijlsma, L. and Sanchez-Arevalo, I. (eds). *Climate Change 2001: Impacts, Adaptation and Vulnerability-Contribution of Working Group II to the 3rd Assessment Report of IPCC.* UNEP. pp. 345–379.

Mangais Eco-Turismo. n.d. Mangrove Communities: Angola. Available at http://www.mangais.com/english/2-e-2_Comun_dos_Mangais_eng.htm (accessed 4 July 2006).

MAP. 2000. *Mangrove Action Project Quarterly News* 7 (1).

Mbendi. 2003. Gabon: Overview. In: Mbendi *Information for Africa.* Available at http://www.mbendi.co.za/land/af/ga/p0005.htm (accessed 3 July 2006).

Ministerio de Recrusos Naturais y Meio Ambiente. n.d. Estratégia nacional y plano de Acção da biodiversidade. Available at http://www.biodiv.org/doc/world/st/st-nbsap-01-p1-pt.doc (accessed 7 July. 2006).

Mongabay. 2006. Guinea Bissau. In: Tropical Rainforests. Available at http://rainforests.mongabay.com/20guinea-bissau.htm (accessed 19 July 2006).

National Geographic. 2001. Central African mangroves (AT1401). Wildworld Ecoregion Profile. Available at http://www.nationalgeographic.com/wildworld/profiles/terrestrial/at/at1401.html (accessed 6 July 2006).

Niasse, M. 2002. Dialogue on Water and Climate in West Africa. IUCN/Global Water Partnership. Available at http://www.waterandclimate.org/dialogue/documents/West%20Africa%20website.pdf (accessed 14 July 2006).

Niasse, M. 2005. Climate-Induced Water Conflict Risks in West Africa: Recognizing and Coping with Increasing Climate Impacts on Shared Watercourses. IUCN-West Africa Regional Office (IUCN-BRAO). Available at http://www.gechs.org/activities/holmen/Niasse.pdf (accessed 14 July 2006).

Nicholls, R.J. 2004. Coastal flooding and wetland loss in the 21st century: changes under the SRES climate and socio-economic scenarios. *Global Environmental Change* 14(1): 69–86.

Nicole, M., Egnankou Wadja, M. and Schmidt, M. (eds). 1994. *A preliminary inventory of coastal wetlands of Côte d'Ivoire.* IUCN Wetlands Programme. IUCN – The World Conservation Union, Gland, Switzerland.

Niger Delta Environment Survey, 1997. *Niger Delta Environmental Survey: final report.* Vols I-IV. Environmental Resources Managers, Lagos.

Nigerian National Planning Commission. 2004. *Meeting Everyone's Needs: National Economic Empowerment and Development Strategy.* Available at http://siteresources.worldbank.org/INTPRS1/Resources/Nigeria_PRSP(Dec2005).pdf (accessed 8 August 2006).

NOAA/NOS. 2002. *Filling Critical Gaps and Promoting Multi-Site Approaches to New Nominations of Tropical Coastal, Marine and Small Island Ecosystems: West Africa.* World Heritage Biodiversity Workshop 25 Feb–1 Mar 2002; Regional Papers: West Africa. Available at http://international.nos.noaa.gov/heritage/pdfs/wes_africa.pdf (accessed 21 July 2006).

Nyong, A. 2005. *The Impacts of Climate Change in the Tropics: The African Experience.* University of Jos, Nigeria. http://www.stabilisation2005.com/Tony_Nyong.pdf (accessed 14 July 2006).

OCHA. 2006. Guinea Bissau: Famine warning issued in south. In: IRIN News. Available at http://www.irinnews.org/report.asp?ReportID=53183&SelectRegion=West_Africa&SelectCountry=GUINEA-BISSAU (accessed 1 August 2006).

Ohimain E.I. 2001. Bioremediation of heavy metal contaminated dredged spoil from a mangrove ecosystem in the Niger Delta. PhD thesis submitted to school of postgraduate studies, University of Benin (UNIBEN), Nigeria.

Ohimain, E.I. 2003. Preservation of Niger Delta Wetland Resources Through Proper Handling and Rehabilitation of Abandoned Waste Sulfidic Dredge Spoils. In: Uzochukwu, G.A., Schimmel, K., Reddy, G.B., Chang, S.Y. and Kabadi, V. (eds). *Proceedings of the 2002 National Conference on Environmental Science and Technology.* Battelle Press, Ohio, USA. pp3–12. Available at http://www.battelle.org/bookstore/BookTemplate.aspx?ISBN=1-57477-138-8.

Ohimain, E. I. 2004. Environmental impacts of dredging in the Niger Delta; options for sediment relocation that will mitigate acidification and enhance natural mangrove restoration. *Terra et Aqua*, 97: 9-19. Available at http://www.iadc-dredging.com/downloads/terra/terra-et-aqua_nr97_06.pdf

Ohimain, E.I. 2006a. Personal communication via email re: West African Mangrove Report. 28 July 2006.

Ohimain, E.I. 2006b. Oil and gas exploration, poverty and environmental unsustainability in the Niger Delta. A paper presented at the International Association for Impact Assessment conference in Stavanger, Norway (May 2006).

Ohimain, E; Andriesse, W; van Mensvoort, M.E.F. 2004. Environmental Impacts of Abandoned Dredged Soils and Sediments: Available Options for their Handling, Restoration and Rehabilitation. *Journal of Soils and Sediments* 4 (1): 59–65. Available at http://www.scientificjournals.com/sj/jss/abstract/ArtikelId/6228

Ohimain, E.I., Benka-Coker, M.O. and Imoobe, T.O.T. 2005. The impacts of dredging on macrobenthic invertebrates in a tributary of the Warri River, Niger Delta. *African Journal of Aquatic Science* 30: 49-53. Available at http://www.ingentaconnect.com/content/nisc/ajas/2005/00000030/00000001/art00007;jsessionid=32joal4htbkci.victoria

Ohimain, E. I. and Imoobe, T.O.T. 2003. Algal bloom in a newly dredged canal in Warri, Niger Delta. *The Nigerian Journal of Scientific Research* 4: 14-21.

Ohimain, E.I., Imoobe, T.O.T. and Benka-Coker, M.O. 2002. Impacts of dredging on zooplankton communities of Warri River, Niger Delta. *African Journal of Environmental Pollution and Health* 1: 37-45.

Okanla, K. 2005. Benin seeks to avert sea disaster. In: BBC News. Available at http://news.bbc.co.uk/1/hi/world/africa/4216902.stm

Quammen, D. 2003. Africa's new parks. In: *National Geographic Magazine*, September 2003. Available at http://magma.nationalgeographic.com/ngm/0309/feature3/?fs=www7.nationalgeographic.com (accessed 3 July 2006).

Ramsar 1999. Ramsar COP 7 Doc. 8. *People and Wetlands: The Vital Link"*, 7th Meeting of the Conference of the Contracting Parties to the Convention on Wetlands, San José, Costa Rica, 10-18 May 1999. Available at http://www.ramsar.org/cop7/cop7_doc_08_e.htm (accessed 2 August 2006).

Ramsar 2000. La Convention Ramsar sur les zones humides. *What's New @ Ramsar. Benin becomes the Convention's 119th Contracting Party.* Available at http://www.ramsar.org/wn/w.n.benin_119th.htm

Ramsar 2001. The Ramsar Convention on Wetlands. *Managing Ghana's Wetlands: A national wetlands conservation strategy.* Available at http://www.ramsar.org/wurc/wurc_policy_ghana.htm (accessed 30 June 2006).

Ramsar 2004. The Ramsar Convention on Wetlands. *The Annotated Ramsar List of Wetlands of International Importance – Mauritania.* Available at http://www.ramsar.org/profile/profiles_mauritania.htm (accessed 6 July 2006.

Ramsar 2006a. *The Annotated Ramsar List of Wetlands of International Importance.* Available at http://www. ramsar.org/profile/profile_index.htm (accessed 30 June 2006).

Ramsar 2006b. Ramsar Sites Information Service. Available at http://www.wetlands.org/rsis/ (accessed 24 July 2006).

Ramsar. 2006c. The Annotated Ramsar List of Wetlands of International Importance: Equatorial Guinea. Available at http://www.ramsar. org profile/profiles_equat_guinea.htm (accessed 30 June 2006).

Ramsar/EPA. 2006. Report on the impacts of the Liberian Civil Crisis on Wetlands. Available at http://www.ramsar.org/swiss/sga_liberia_postconflict_rpt.pdf (accessed 1 August 2006).

Sackey, I., Laing, E. and Adomako, J.K. 1993. Status of the Mangroves of Ghana. In: Diop, E.D. ed. *Conservation and Sustainable Utilization of Mangrove Forests in Latin America and Africa Regions. Part II – Africa.* International Society for Mangrove Ecosystems and Coastal marine Project of UNESCO. Mangrove Ecosystems Technical Reports 3

Saenger, P. and Bellan, M.F. 1995. *The Mangrove Vegetation of the Atlantic Coast of Africa.* Université de Toulouse Press, Toulouse.

Sagno, K.C., 2005. *Rapport National 2004 – 2005 De La Guinée.* L'accord Sur La Conservation Des Oiseaux D'eaux, Migrateurs, D'afrique –Eurasie 2005.

Said, A.R. 2007. Personal communication via email through the Abidjan Convention Secretariat. Re: Review of Report – Mangroves of West Africa. 5 March 2007.

Samoura, K. and Diallo, L. 2003. Environmental issues associated with the main sectors of energy production in Guinea *AJEAM-RAGEE* 5: 28–38.

Shalovenkov, N.N. 2000. Development of mangrove woods and their influence on bioproductivity of coastal shelf of Republic of Guinea (West Africa). 13. Jahrestagung der Deutschen Gesellschaft für Tropenökologie gtö 2000, 1.-3. März 2000, Würzburg.

Shumway, C.A. 1999. Forgotten Waters: Freshwater and Marine Ecosystems in Africa.. Strategies for Biodiversity Conservation and Sustainable Development. Available at http://www.uneca.org/awich/FORGOTTEN%20WATERS FRESHWATER% 20AND.pdf (accessed 26 July 2006).

Simpson, S. 2003. Ghana's trade gains from conflict. In: *BBC Business.* Available at http://news.bbc.co.uk/1/hi/business/3205723.stm (accessed 25 May 2007).

Spalding, M.D., Blasco, F. and Field, C.D., eds. 1997. *World Mangrove Atlas.* The International Society for Mangrove Ecosystems, Okinawa, Japan.

Togolese National Strategy for mangroves Conservation. 2005.

Tomlinson, P.B. 1986. *The Botany of Mangroves.* Cambridge University Press, Cambridge, UK. (Reprinted in 1996).

Tshibasu, M. n.d. *Importance De L'evaluation Environnementale En Republique Democratique Du Congo : Cas Du Parc Marin Des Mangroves.* Available at http://www.sifee.org/publications/mangroves.pdf

Ukwe, C.N., Ibe. C.A.; Alo, B.I.; Yumkella, K.K. 2003. Achieving a paradigm shift in environmental and living resources management in the Gulf of Guinea: the large marine ecosystem approach. *Marine Pollution Bulletin* 47 (1-6): 219-225.

UNEP. 1990. Island Directory: Islands of Sao Tome and Principe. UN System-Wide Earthwatch Web Site. Available at http://islands.unep.ch/IQD.htm (accessed 3 August 2006).

UNEP-GPA. 2006. Global Marine Litter Information GatewayGulf of Guinea Large Marine Ecosystem Project http://marine-litter.gpa.unep.org/framework/region-10-next.htm. (accessed 11 July 2006)

UNEP/Nasi, R. 2001. The Case of Gabon. In: Integration of Biodiversity in National Forestry Planning Programme held in CIFOR Headquarters, Bogor, Indonesia, August 2001. Available at http://www.unep.org/bpsp/Forestry/Forestry%20Case%20Studies/Gabon.pdf (accessed 3 July 2006).

UNEP-WCMC. 2002. Site sheet: Banc d'Arguin National Park, Mauritania. WDPA. Available at http://sea.unep-wcmc.org/sites/wh/bancd'ar.html (accessed 05 July 2006).

UNEP-WCMC. 2003. Mangroves of East Africa. UNEP-WCMC Biodiversity Series No. 13. Available at http://www.unep-wcmc.org/resources/publications/ss1/WCMCMangrovesv11_1.pdf (accessed 11 July 2006).

UNEP-WCMC. 2006a. *In the Front Line: Shoreline Protection and Other Ecosystem Services from Mangroves and Coral Reefs.* Cambridge, UK.

UNEP-WCMC. 2006b. Spatial data layer of Mangrove distribution derived through Landsat image classification, UNEP-WCMC, Cambridge, UK. Data analysis, July 2006. Cambridge, UK.

UN/World Bank. 2004. Liberia: National Transition Government of Liberia. Joint Needs Assessment. Available at http://www.cifor.cgiar.org/publications/pdf_files/reports/assessment.pdf (accessed 18 July 2006).

US Department of State. 2006a. Background Note: Togo. Bureau of African Affairs. Available at http://www.state.gov/r/pa/ei/bgn/5430.htm (accessed 5 July 2006).

US Department of State. 2006b. Bureau of African Affairs. Background Note: Republic of the Congo. Available at http://www.state.gov/r/pa/ei/bgn/2825.htm (accessed 3 July 2006).

Vande Weghe, J.P. 2006. Personal communication via email re: Mangroves of E.G. 31 July 2006.

Vannucci, M. 1989. *The Mangroves and Us: a Synthesis of Insights.* Indian Association for the advancement of Science, New Delhi, India.

Vannucci, M. 1997. Supporting appropriate mangrove management. *Intercoast Network Special Edition* 1: 1, 3, 42.

Viles, H. and Spencer, T. 1995. *Coastal Problems.* Edward Arnold, London.

Wildlife Conservation Society (WCS). 2006. Letter from the field: Conkouati. Available at http://www.wildlife conservation.org/wcm-home/wcm-article/26446646 (accessed 2 August 2006).

Wiles, D. 2005. *Coastal Zone Vulnerability and Adaptation to Climate Change in Liberia.* Training Workshop on Adaptation and Vulneration to Climate Change. Maputo Mozambique. April 18–22, 2005. Available at http://unfccc.int/files/national_reports/non annex_i_natcom/ meetings/application/pdf/20050419wiles.pdf (accessed 18 July, 2006).

World Bank. 1993. Democratic Republic of Sao Tomé and Principe. Country economic memorandum Vol. II. Key elements of an environmental strategy. World Bank Intern. Discuss. Paper.

World Bank, 1994. Africa: A Framework for Integrated Coastal Zone Management.

World Bank, ISME, Center Aarhus. 2003. Draft Code of Conduct for theSustainable Management of Mangrove Ecosystems

WRI. 2003a. Armed Conflict, Refugees, and the Environment. *World Resources 2002-2004* (Box 2.1, pp.25–27). Available at http://earthtrends.wri.org/pdf_library/features/gov_fea_conflict.pdf (accessed 18 July 2006).

WRI. 2003b. Earthtrends Country Profiles Coastal and Marine Ecosystems – Dem. Rep. of the Congo. Available at http://earthtrends.wri.org/pdf_library/country_profiles/coa_cou_180.pdf (accessed 25 May 2007).

WWF. 2001. Terrestrial Eco-regions: East African Mangroves. Available at http://www.worldwildlife.org/wildworld/profiles/terrestrial/at/at1402_full.html (accessed 21 July 2006).

Yansane, A. 1998. Le schéma directeur d'aménagement de la mangrove de Guinée. *Bulletin du centre de Rogbané* 12: 210–223.

Annex 2: Mangrove Species of West Africa

Rhizophora mangle (Red Mangrove)

Rhizophora mangle is a small to medium-sized tree of 10 to 20 metres in height and 10 to 30 centimetres diameter at breast height (d.b.h). However, it may exceed 40 metres in height and 70 centimetres d.b.h. on productive sites (Jimenez, 1985). It typically grows along the water's edge and is easily identifiable by its tangled, reddish 'prop-roots'.
Method of propagation: seeds sprout while they are still on the trees and drop into the soft bottom around the base of the trees. Currents and tides may also transport them to other suitable locations where they can settle into the soft bottom and grow (Florida Keys NMS, 2006; Law, FRC-43).

Avicennia germinans (Black Mangrove)

Avicennia germinans is characterized by numerous finger-like projections, called pneumatophores, which protrude from the soil around the tree's trunk; a 3-metre tall *Avicennia* can have 10 000 pneumatophores (Tan, 2001). This species tend to occupy slightly higher elevations inland from the red mangrove.

Method of propagation: seeds sprout while they are still on the trees and drop into the soft bottom around the base of the trees. Currents and tides may also transport them to other suitable locations where they can settle into the soft bottom and grow (Florida Keys NMS, 2006; Law, FRC-43).

Laguncularia racemosa (White Mangrove)

Laguncularia racemosa has no visible aerial roots and is most easily identified by its leaves. They are elliptical, light yellow-green, and have two distinguishing glands at the base of the leaf where it meets the stem. This species tends to occupy higher elevations farther upland than either the red or black mangroves.

Method of propagation: seeds sprout while they are still on the trees and drop into the soft bottom around the base of the trees. Currents and tides may also transport them to other suitable locations where they can settle into the soft bottom and grow (Florida Keys NMS, 2006; Law, FRC-43).

Conocarpus erectus (Buttonwood)

Conocarpus erectus is in the same family as the white mangrove. The name is derived from the button-like appearance of the dense, rounded flower heads that grow in a branched cluster, and the purplish-green, round, cone-like fruit (Law, FRC-43).

Acrostichum aureum (Golden Leather Fern)

An erect fern, growing up to 1.5 metres high, with a small bushy appearance. It has typical fibrous, fern-like roots without any aerial roots. The frond is simple, up to 1 metre long and 4 centimetres wide, isobilateral, distinct mid-vein and reticulate vein, entire, blunt end, green and yellow on maturity with sorus, glabrous, coriaceous, unicostate reticulate venation. Mature fronds become sporophyllous, diffuse sporangia at abaxial surface, mixed sporangia on both sides of the mid-vein, brown sporangia stalked, upper globose (Mangroves of India, 1998).

Nypa fruticans (Mangrove/Nypa Palm)

A palm that grows in the soft mud, usually where the water is calmer, but where there is regular inflow of freshwater and nutritious silt. They can be found inland, as far as the tide can deposit the Palm's floating seeds. It can tolerate infrequent inundation, as long as the soil does not dry out for too long. The horizontal creeping stems stabilize riverbanks, preventing soil erosion (Tan, 2001; Missouri Botanical Garden, 1996).

Rhizophora racemosa (Red Mangrove)

Rhizophora racemosa is less common than *R. mangle*. The distribution appears restricted, mostly to equatorial estuaries of larger river systems with more continuous freshwater flows (Duke, 2006). It is the primary colonist in the open lagoon systems in areas along the coastlines of Ghana, Nigeria, Cameroon, Equatorial Guinea, Gabon, Democratic Republic of the Congo and Angola (WWF, 2001).

Rhizophora harrisonii (Red Mangrove)

The taxon is considered the putative hybrid of *R. mangle* and *R. racemosa*. *Rhizophora harrisonii* is the apparent hybrid of *R. mangle* and *R. racemosa*, based on its intermediate and shared morphological characteristics. Further investigations are needed to adequately describe *Rhizophora* taxa and their distributions throughout the Atlantic East Pacific region (Duke, 2006). FAO recognizes *Rhizophora harrisonii* as a distinct species (FAO, in press). The distribution appears restricted mostly to equatorial estuaries of larger river systems with more continuous freshwater flows (Duke, 2006).

References:

Duke, N. 2006. *Rhizophora mangle, R. samoensis, R. racemosa, R. harrisonii* (Atlantic–East Pacific red mangroves), ver. 2.1. In: Elevitch, C.R. (ed.). Species Profiles for Pacific Island Agroforestry. Permanent Agriculture Resources (PAR), Hÿlualoa, Hawai'i. http://www.traditionaltree.org. Accessed 08 August 2006.

Jimenez, J. 1985. *Rhizophora mangle* – Red Mangrove. SO-ITF-SM-2. US Government Printing Office, Washington, D.C.

Law, B. and N. Pyrell. *Mangroves – Florida's Coastal Trees.* Forest Resources and Conservation Fact Sheet. FRC-43 University of Florida/Cooperative Extension Service/Institute of Food and Agricultural Sciences http://www.sfrc.ufl.edu/Extension/pubtxt/for43.htm. Accessed 07 August 2006.

Mangroves of India. 1998. *Acrostichum aurem:* Linnaeus. http://www.indian-ocean.org/bioinformatics/mangrove/mangcd/indo/p1.htm. Accessed 07 August 2006.

Missouri Botanical Garden. 2005. Historia naturalis palmarum: opus tripartium / Carol. Frid. Phil. de Martius. Lipsiae: T.O. Weigel, [1823-50] http://www.illustratedgarden.org/mobot/rarebooks/page.asp?relation=QK495F21M34182350V3&identifier=0349. Accessed 07 August 2006.

Florida Keys National Marine Sanctuary. 2006. Sanctuary Resources: Florida's mangroves. http://floridakeys.noaa.gov/sanctuary_resources/moremangrove.html. Accessed 07 August 2006

Tan, R. 2001. Nipah Palm: Nypa Fruticans. http://www.naturia.per.sg/buloh/plants/palm_nipah.htm. Accessed 07 August 2006.

WWF. 2001. Central African mangroves (AT1401). WildWorld WWF Full Report. http://www.worldwildlife.org/wildworld/profiles/terrestrial/at/at1401_full.html. Accessed 08 August 2006.

Annex 3: Contributing Mangrove Experts

Country	Name	Email	Title/Affiliation
Cameroon	*Ndongo Din*	ndongodin@yahoo.com	Head of Department of Botany; Faculty of Science; The University of Douala, Cameroon
	Gordon Ajonina	cwcsmko@yahoo.fr	Cameroon Wildlife Conservation Society (CWCS)
	Jean Nke	jean_nke@yahoo.com	Défense de l'Environnement Camerounais
Côte d'Ivoire	*Abou Bamba*	bamba@ramsar.org	Ramsar Senior Advisor for Africa
Equatorial Guinea	*Gail W. Hearn*	Hearng@arcadia.edu	Professor of Biology, Arcadia University
Gabon	*Jean Pierre Vande weghe*	jpvandeweghe@hotmail.com	Wildlife Conservation Society scientist
Ghana	*Joana Akrofo*	Joana.akrofi@unep.org	Division for Early Warning and Assessment, UNEP
	A.K. Armah	akarmah@ug.edu.gh	Department of Oceanography & Fisheries, University of Ghana
	Chris Gordon	cgordon@ug.edu.gh	Project Coordinator: GLOMIS/ University of Ghana
Nigeria	*Elijah Ohimain*	eohimain@yahoo.com	Environmental/petroleum microbiologist
	Ayobami T. Salami	ayobasalami@yahoo.com	Head, Space Applications and Environmental Science Laboratory, Institute of Ecology & Environmental Studies,Obafemi Awolowo University, Ilelfe, Nigeria.
Togo	*Ebeh Adayade Kodjo*	ebeh@cooperation.net	Executive Director: Association Nationale des Consommateurs et de l'Environnement (ANCE-TOGO)
	Abilio R. Said		Review at the request of the Secretariat of the Abijan Convention
Regional	*Salif Diop*	Salif.diop@unep.org	Division for Early Warning and Assessment, UNEP

Annex 4: An Economic Toolbox for placing value on mangrove products and services

Product/Service	Valuation Methods
Forestry products	• Demand/supply analysis • Market prices • Surrogate market prices
On-site fisheries products (crabs, fish)	• Production function approach
Supporting off-site fisheries (fish, shrimp)	• Production function approach
Aquaculture products (fish, shrimp)	• Demand/supply analysis • Market prices
Carbon sequestration	• Reduction in expected future damage cost from climate change
Traditional medicinal plants	• Substitute price • Contingent valuation
Biodiversity conservation:	
• Potential medicinal plants	• Expected value of plant as a source of medicine
• Ecotourism	• Travel cost method
• Non-use values	• Contingent valuation
Other non-use related benefits	• Contingent valuation

Source: Spaninks, F. and van Beukering, P. 1997. Economic Valuation of Mangrove Ecosystems: Potential and Limitations. CREED Working Paper Series 14. IIED.

Mangroves of Western and Central Africa

Biodiversity makes possible all forms of economic activity. Damage to components of biodiversity have economic consequences, the impacts of which fall most heavily on the poor. In few contexts is this as clear as in the case of mangrove ecosystems and their dependent human populations. Mangroves support livelihoods in providing habitat for food species, timber for dwellings, cooking and heat, and many other subsistence and commercial activities. Mangroves also provide protection of the coastline from erosion and storm surges. The roles of mangroves are now being realized, but only as the general trend for this valuable habitat is decline.

This report presents a country profile for 19 countries of West and Central Africa, considering the status, distribution, biodiversity, uses, threats and drivers of change for their mangroves. Although there is considerable work being undertaken to research this habitat at the national, regional and global level, there are still significant gaps in information, emphasizing a need for continued efforts to improve assessment in the region.

This report concludes that there has been a decline in mangrove cover in the region over the last quarter of a century, and that there will be consequences as a result of this decline.

www.unep.org
United Nations Environment Programme
P.O. Box 30552, Nairobi 00100, Kenya
Tel: +254 (0) 20 7621234
Fax: +254 (0) 20 7623927
Email: uneppub@unep.org
Website: www.unep.org

UNEP

UNEP World Conservation Monitoring Centre
219 Huntingdon Road, Cambridge
CB3 0DL, United Kingdom
Tel: +44 (0) 1223 277314
Fax: +44 (0) 1223 277136
Email: info@unep-wcmc.org
Website: www.unep-wcmc.org

UNEP-WCMC Biodiversity Series No 26

ISBN: 978-92-807-2792-0

June 2007 DEW/0913/CA